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# North American Aviation, Inc.

NA-59-1736

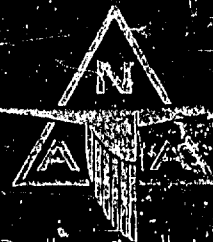
(C) SUMMARY OF XP-70 FLUTTER MODEL  
TESTS FROM 1 MARCH 1958 TO 20 MAY 1960

NAA DESIGNATION NA-267

AF DESIGNATION XP-70

CONTRACT AF 33(600)-38669

THIS REPORT CONTAINS BAS OF POOR  
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International Airport, Los Angeles 48, California

LOS ANGELES DIVISION

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9

Report No. **NA-59-1736**

**ENGINEERING DEPARTMENT**

CONTRACT AF 33(600)-38669

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R. W. Deckman & H. K. Arnold

*H. H. Crotsley*  
H. H. Crotsley  
Chief, Aero Science

Date **30 June 1960**

FD-302, REV. 1-72

62. ASR 5-1756

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		MODEL NO. XB-70

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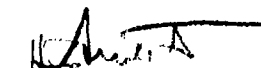
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		MODEL NO. XB-70

### ABSTRACT

Model characteristics, flutter speeds, frequencies, test conditions and other data pertinent to flutter evaluation of the B-70 configurations under consideration are herein presented. The data accumulated have been used to specify stiffness levels required to prevent flutter of the XB-70 Air Vehicle.

### FOREWORD

The data presented in this report were compiled during March 1, 1958 to May 20, 1960 as a part of flutter development under Contract No. AF 33(600)-38669. This flutter model test analysis report is submitted in accordance with page 23, item 6, paragraph 4 of Appendix C of Contract AF 33(600)-38669. This report was prepared by R. W. Deckman and H. K. Arnold.

  
H. R. Sweet, Supervisor  
Vibration, Flutter, & Acoustics

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### SUMMARY

Analyses of, and conclusions reached, from all XB-70 flutter model tests conducted during the period 1 March 1958 through 20 May 1960 are presented. The unusually low sea level mass ratios of the XB-70 A/V necessitated extensive use of low density styrofoam in the model fabrication. These low mass ratios also lead to problems with oscillatory flow characteristics of the North American Low Speed Tunnel (NAAL) and showed the necessity of tunnel modifications to improve the flow prior to further tests of complete XB-70 models.

A flutter boundary through the subsonic and transonic range has been obtained for the vertical stabilizer and the results used to specify hinge point, actuator and vertical stabilizer stiffness requirements. Low speed flutter model data on the canard have shown that the most critical condition is with the flaps unlocked; the test results have been used to specify flap actuator stiffness and flap stiffnesses (both locked and unlocked conditions), canard root stiffness, canard stiffness, and to specify the requirement for a flaps locked indication to the pilot. Subsonic and transonic test data of the wing have been used to specify wing stiffness and wing fold stiffness requirement; the test results show that for the stiffness specified the minimum flutter margins are to be expected at sea level transonic speeds.

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### SUSPENSION SYSTEM AND .03 SCALE COMPLETE MODEL

The purpose of this test was to evaluate a new spring suspension system designed for testing complete flutter models. The results of fourteen runs varying the elastic axis of the suspension system with respect to c.g. of the model indicated that the suspension system would adequately perform the desired function.

The suspension system was designed on the following assumptions:

translation	=	1.7 cps
rotation	=	2.12 cps
roll		no requirement

The model mass parameters assumed were as follows:

M	=	.0334 lb-in-sec. <sup>2</sup>
I <sub>pitch</sub>	=	5.63 lb-in-sec. <sup>2</sup>
I <sub>yaw</sub>	=	6.38 lb-in-sec. <sup>2</sup>
I <sub>roll</sub>	=	.863 lb-in-sec. <sup>2</sup>

The suspension system stiffness requirements were then:

K <sub>translation</sub>	3.77 lb/in.
C <sub>rotation</sub>	1000 in-lb/rad.

To meet the above stiffness requirements six springs with a spring constant of 5.38 lbs/in. were selected. A diagram of the suspension system set-up is shown in Figure 1.

The .03 scale complete model represented external geometry, mass, c.g., and inertia about three axis of a "rigid" -127 configuration at sea level. The measured frequencies of model rigid body modes are as follows:

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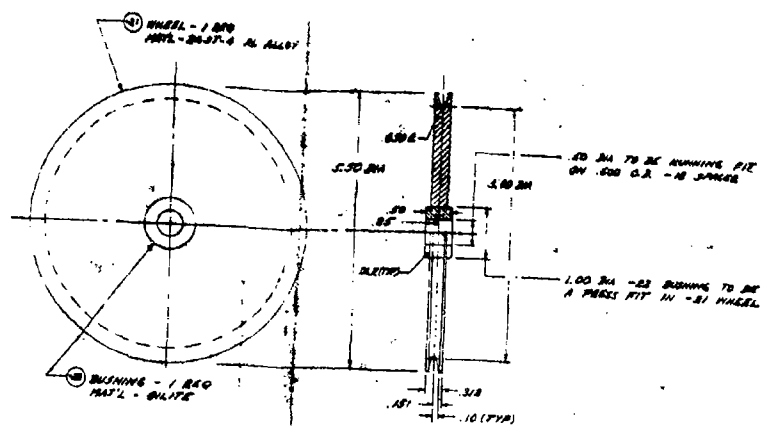
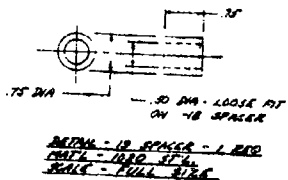
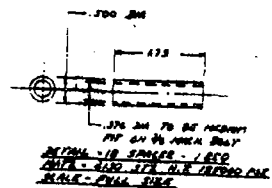
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SUSPENSION SYSTEM AND .03 SCALE COMPLETE MODEL (Con't)

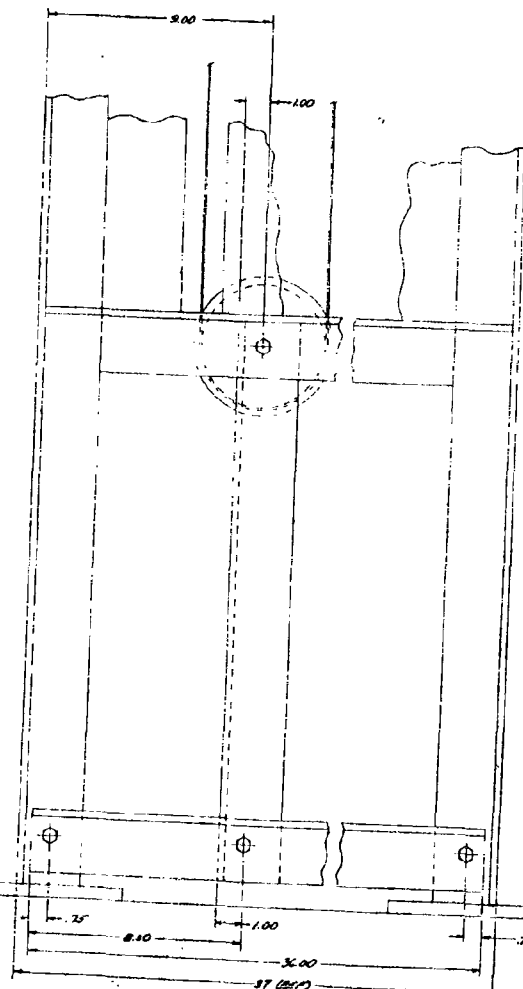
$f$ pitch = 2.4 cps	$f$ vertical translation = 1.75 cps
$f$ yaw = 2.17 cps	$f$ side translation = 1.78 cps
$f$ roll $\approx$ 2.85 cps	$f$ fore & aft translation = 4.0 cps

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1

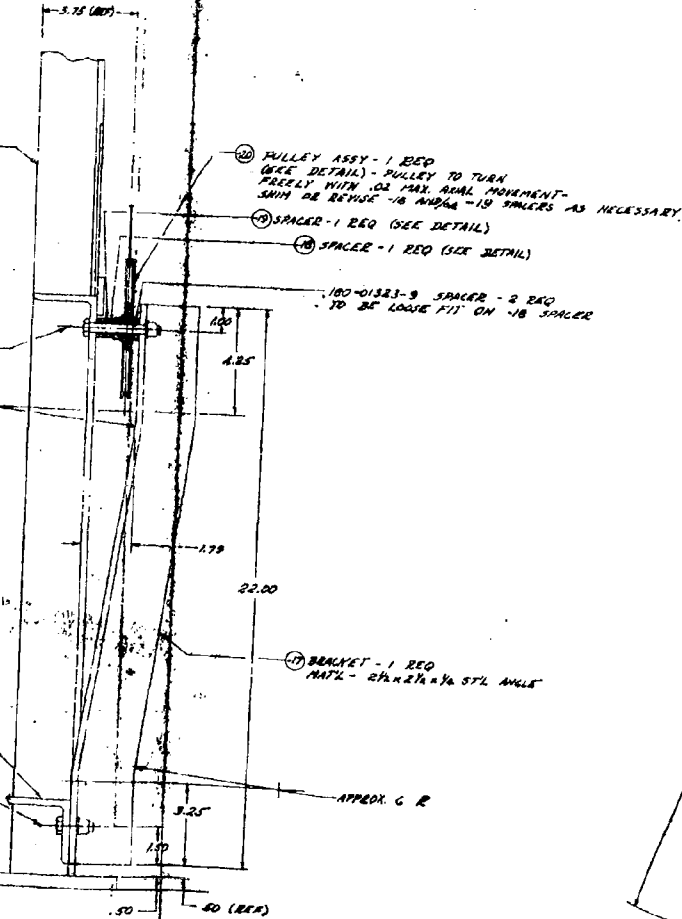


100-01317-23 CONTROL PANEL  
FRAME (REF)

3/4 INCH BOLT, 2.25 GRIP  
LENG. - 1 REQ  
3/8 INCH HD LOCK NUT - 1 REQ  
APPROX 6 R

SUPPORT ANGLE - 1 REQ  
MATERIAL - 20-27-6 AL  
STYL ANGLE

3/4 INCH BOLT, 50 GRIP  
LENG. - 3 REQ  
3/8 INCH HD LOCK NUT - 3 REQ



VIEW C-C  
SCALE - HALF SIZE

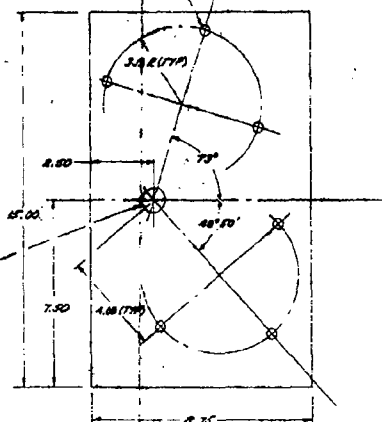
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1.75

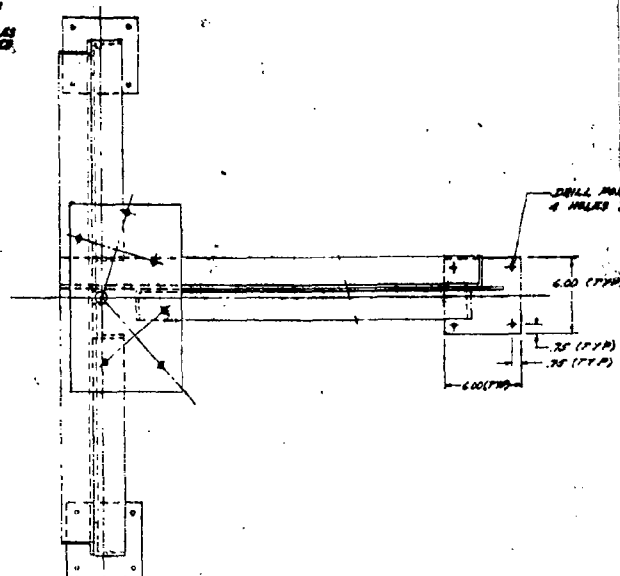


1.00 MM - 1 HOLE —

DRILL FOR 2 HOLES - 6 HOLES 100% HIT  
TO MATCH SLOT IN 100-00000-0 BOLT  
PLATE. NOTE: FOR THE 4575.000, 3  
HOLES IN 2ND BOLT PATTERN MAY BE  
OMITTED IN ONE PART & THE 3 HOLES  
IN THE 4575.000 BOLT PATTERN OMITTED  
IN THE SECOND PART

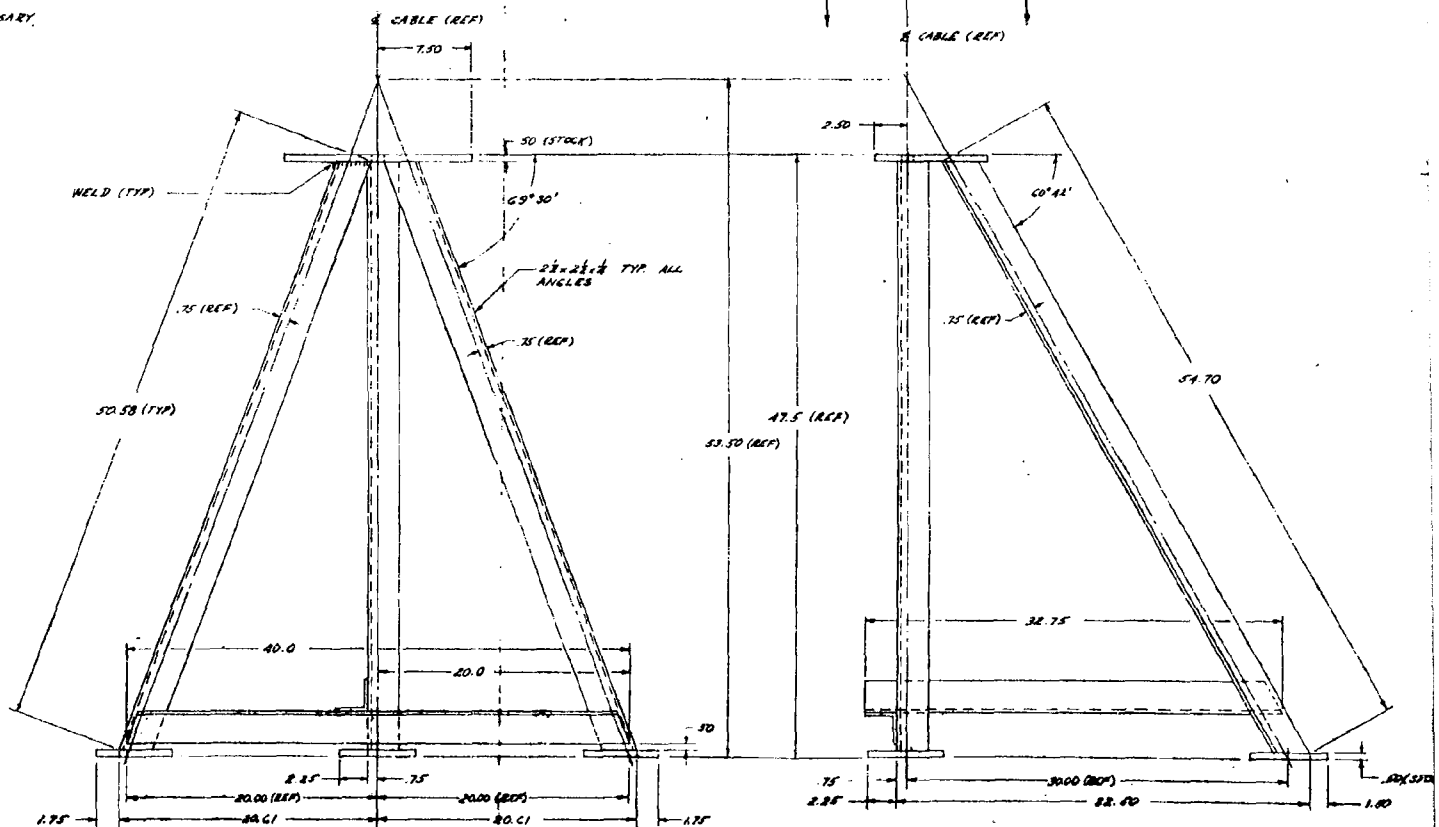


VIEW 13-13  
SCALE: 1/2" = 1'-0"



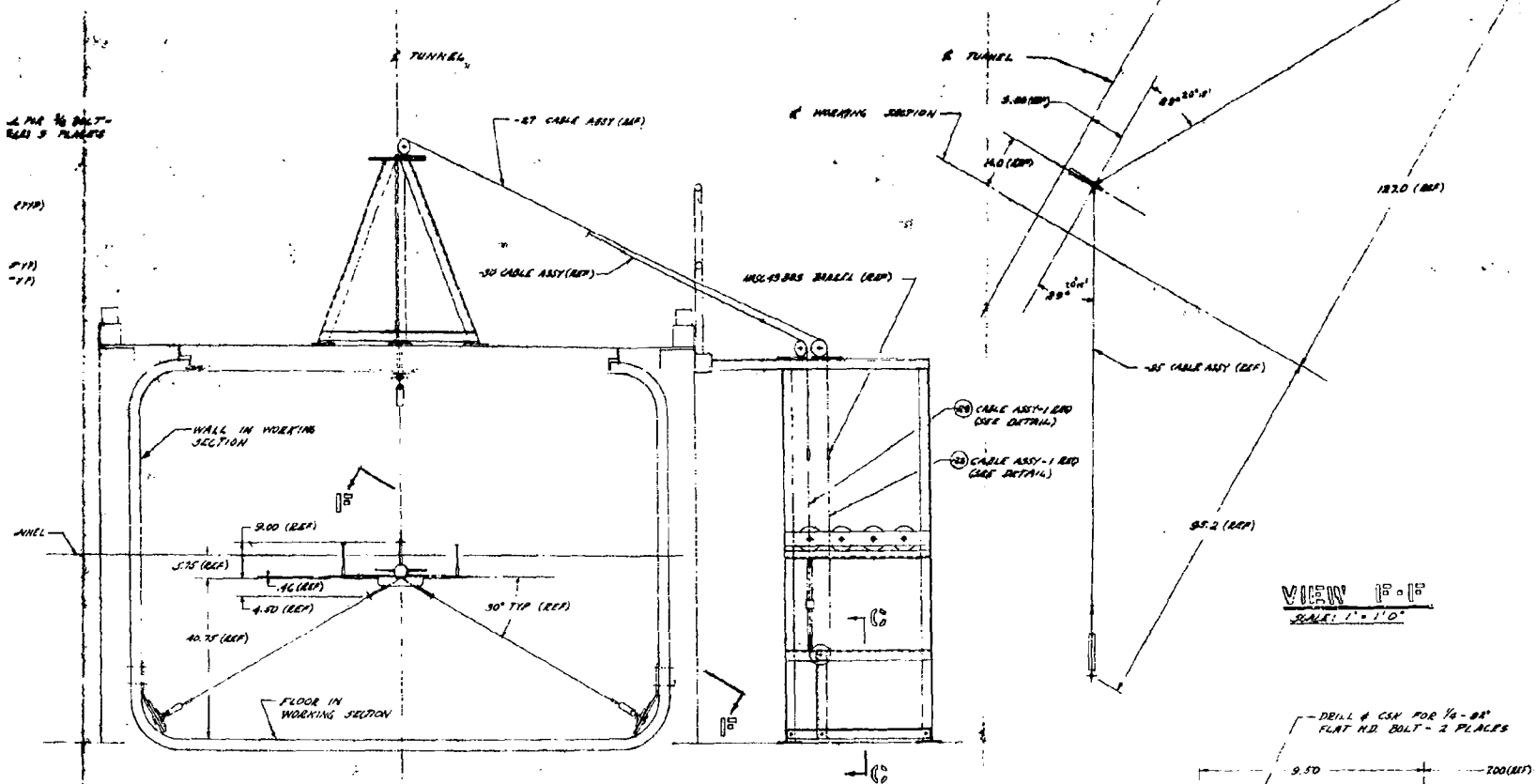
6 TUNNEL

NER - 2 REQ  
T ON -18 SPACER



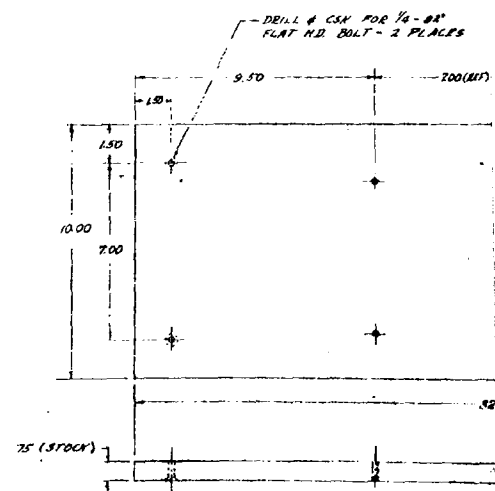
DETAIL - 16 TRIPOD WELDMENT - 2 REQ  
 MATL: 1020 ST.  
 WELD: WELD ALONG ALL EXPOSED LIMITS OF  
 MEMBERS OF ADJOINING PARTS  
 SCALE: 3/4" = 1"

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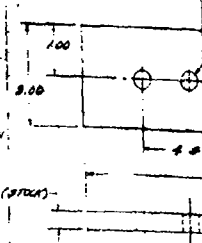
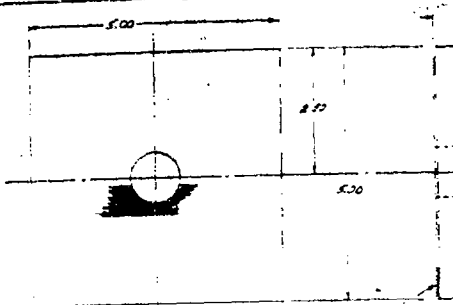
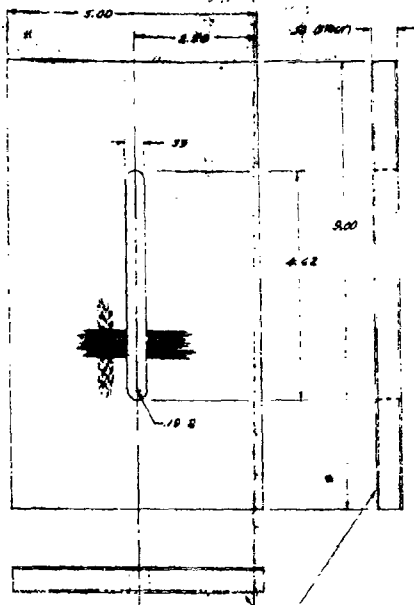


VIEW D-D  
SCALE: 1" = 1'-0"

3



DETAIL - 14 R  
SCALE:  
MATH:



SERRATIONS - 1/4 PITCH  
0.40 DEPTH - OVER  
5.00 x 5.00 AREA

DETAIL - 1/4 PLATE - 4 REQ (1 PER ASSY)  
SCALE: FULL SIZE  
MATCH: 1050 STD

SERRATIONS - 1/4 PITCH  
0.40 DEPTH - OVER  
5.00 x 9.00 AREA

DETAIL - 1/4 PLATE - 4 REQ (1 PER ASSY)  
SCALE: FULL SIZE  
MATCH: 1050 STD

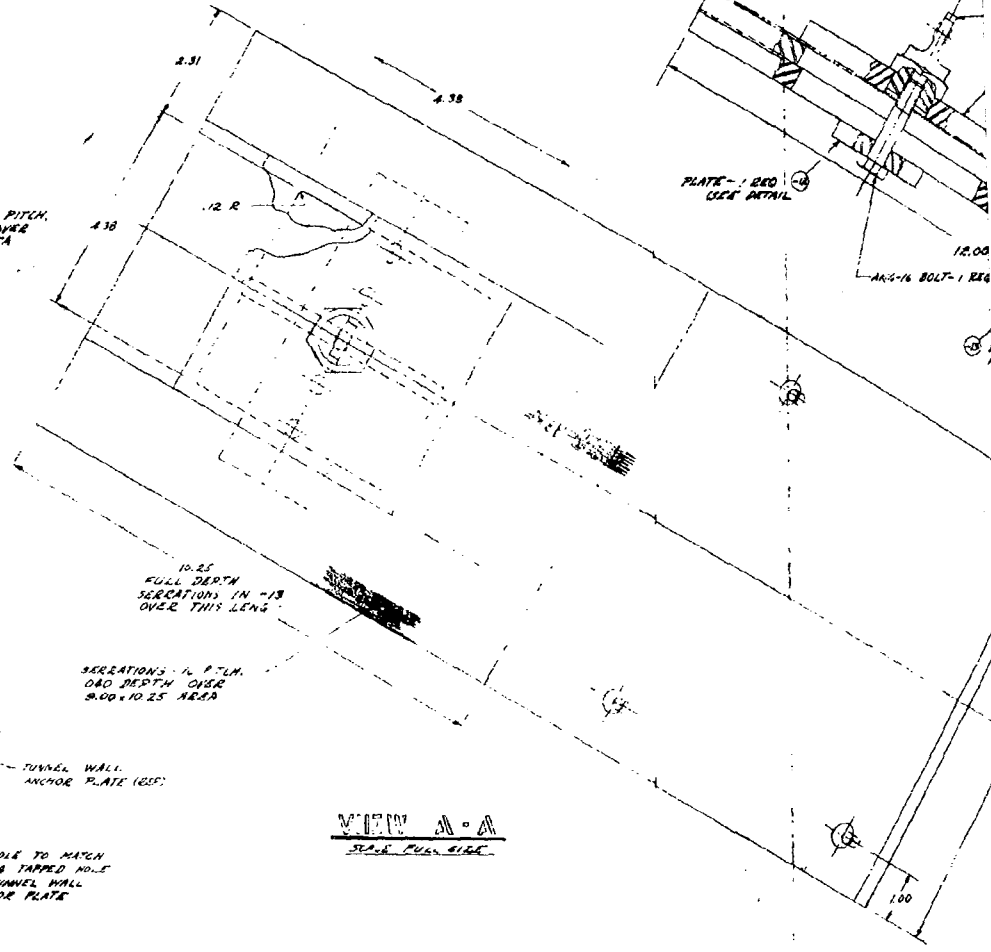


PLATE - 1 REQ  
SEE DETAIL

AN-1/4 BOLT - 1 REQ

DRILL & TAP 4 HOLES FOR 1/4-20 TND  
HOLE PATTERN TO MATCH C&T HOLES  
IN -13 BRKT (SEE DETAIL -2)

1/2 DIA HOLE TO MATCH 1/4-16  
TAPPED HOLE IN TUNNEL WALL  
ANCHOR PLATE

10.25  
FULL DEPTH  
SERRATIONS IN -13  
OVER THIS LENG

SERRATIONS - 1/4 P.T.M.  
0.40 DEPTH OVER  
9.00 x 10.25 AREA

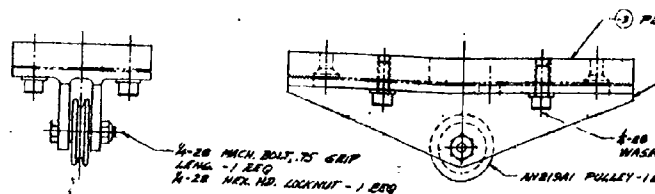
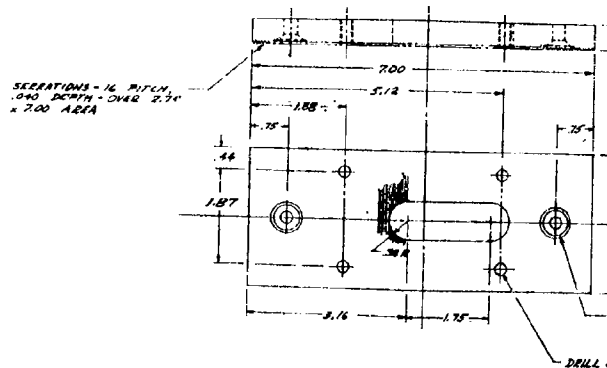
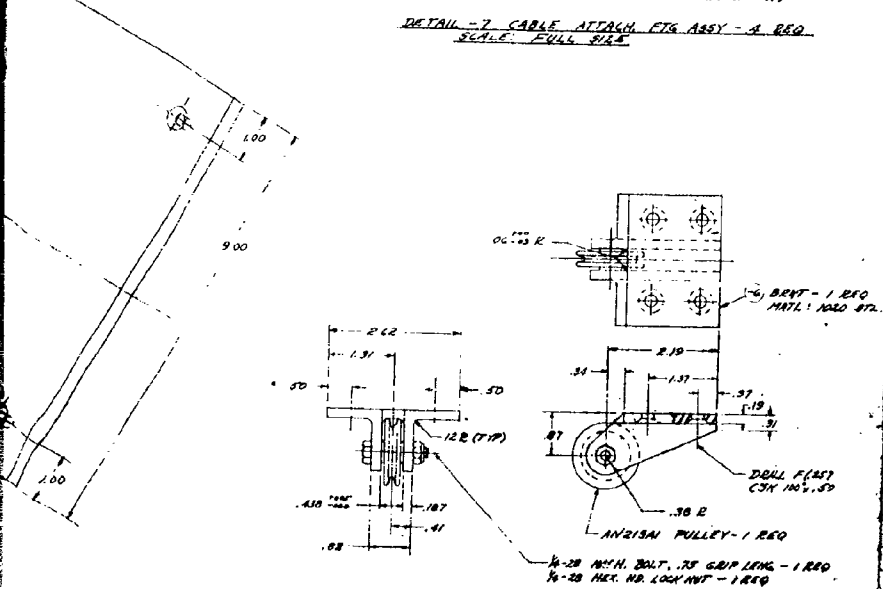
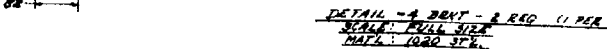
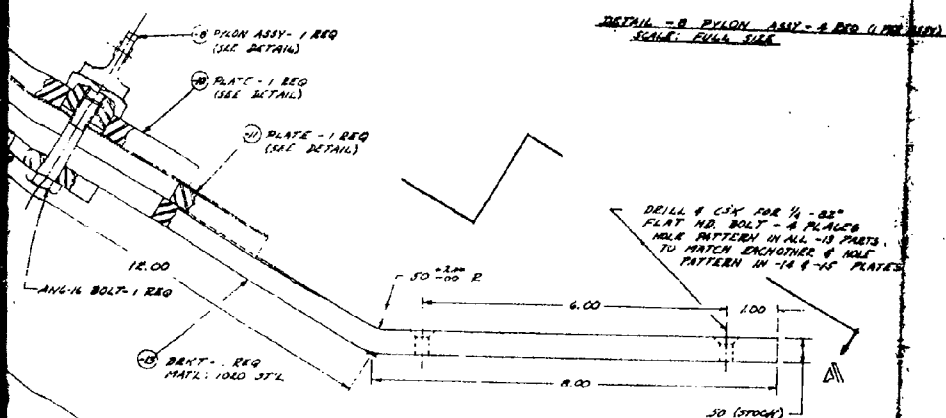
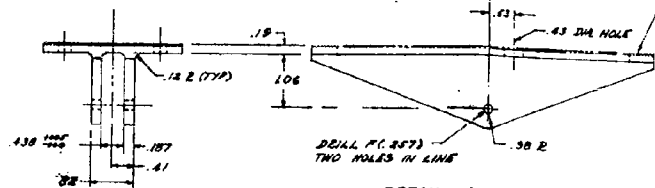
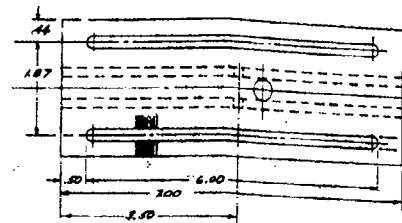
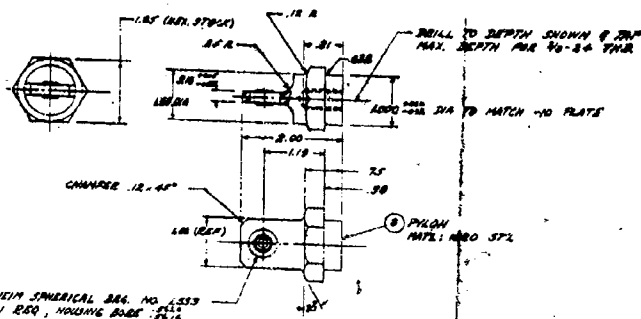
TUNNEL WALL  
ANCHOR PLATE (REF)

3/8 HOLE TO MATCH  
1/4-20 TAPPED HOLE  
IN TUNNEL WALL  
ANCHOR PLATE

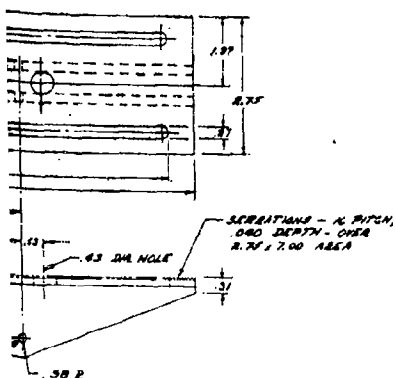
VIEW A-A  
SCALE: FULL SIZE

41 - 1A BY 8 - 15 AN SUPPORT PLATES - 1 EA REQ  
SCALE: 1/2 SIZE  
MATCH: 1050 STD

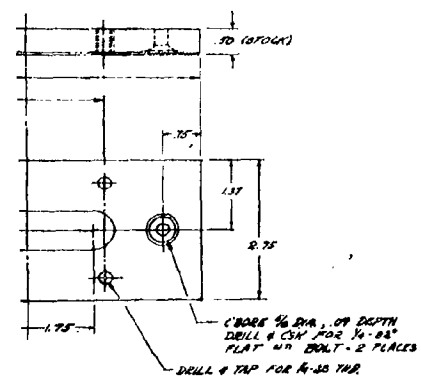
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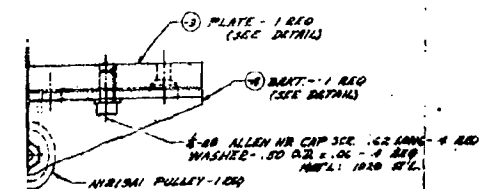
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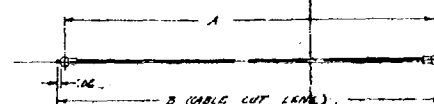
304T - 2 REQ (1 PER ASSY)  
ALL SIZES  
RO. 37.5



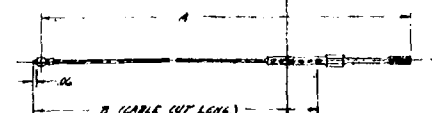
-3 PLATE - 2 REQ (1 PER ASSY)  
ALL SIZES  
RO. 1000 STL



PULLEY BENT ASSY - 2 REQ  
ALL SIZES



TYPE "B" CABLE ASSY  
SCALE: FULL SIZE



TYPE "A" CABLE ASSY  
SCALE: FULL SIZE

CABLE ASSY PART NO.	NR REQ.	TYPE	APPROX. LENGTH "A"	APPROX. LENGTH "B"	END FITTINGS - 1 EA. REQ/ASSY		LOCATION OF CALL-OUT
					LEFT END	RIGHT END	
-24	4	A	7.4	5.7	AN66C2	AN66C2	SIDE VIEW
-25	2	A	107.5	106.8	AN66C2	AN66C2	
-26	2	A	111.9	110.8	AN66C2	AN66C2	
-27	1	A	250.0	248.8	AN66C2	AN66C2	
-28	1	A	83.0	81.3	AN66C2	AN66C2	VIEW B-D
-29	1	A	27.0	25.3	AN66C2	AN66C2	
-30	1	A	240.0	238.8	AN66C2	AN66C2	SIDE VIEW
-31	1	B	78.3	78.0	AN66C2	AN66C2	
-32	1	B	75.1	74.8	AN66C2	AN66C2	

#### DETAIL OF CABLE ASSES

- NOTES:
1. USE 1/4 IN CARBON STEEL CABLE, 40% MIN. C-10TH, FOR ALL ASSYS.
  2. SINGLE TERMINALS FOR AN-T-117 (PAGE-1).
  3. TEST ALL ASSYS. AT 800 LBS FOR AN-C-5000 (PAGE-1).
  4. IDENTIFY ALL ASSYS WITH THE ABOVE FABRICATION.

6

EQ/ASSY - AND	LOCATION OF CALL-OUT
P-38R	SIDE VIEW
P-38L	
D-38L	
D-38R	
D-38L	VIEW B-B
D-38R	
D-38L	SIDE VIEW
PCA	
PLC	

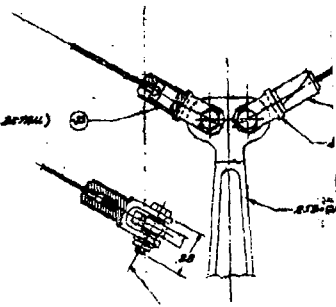
7

PLAN  
SCALE: 1" = 1'

10 (REF)  
10 (REF)  
10 (REF)

DETAIL - AL SPACER - 10 (REF)  
ASSEMBLY IN PROGRESS (REF)  
SCALE: FULL SIZE

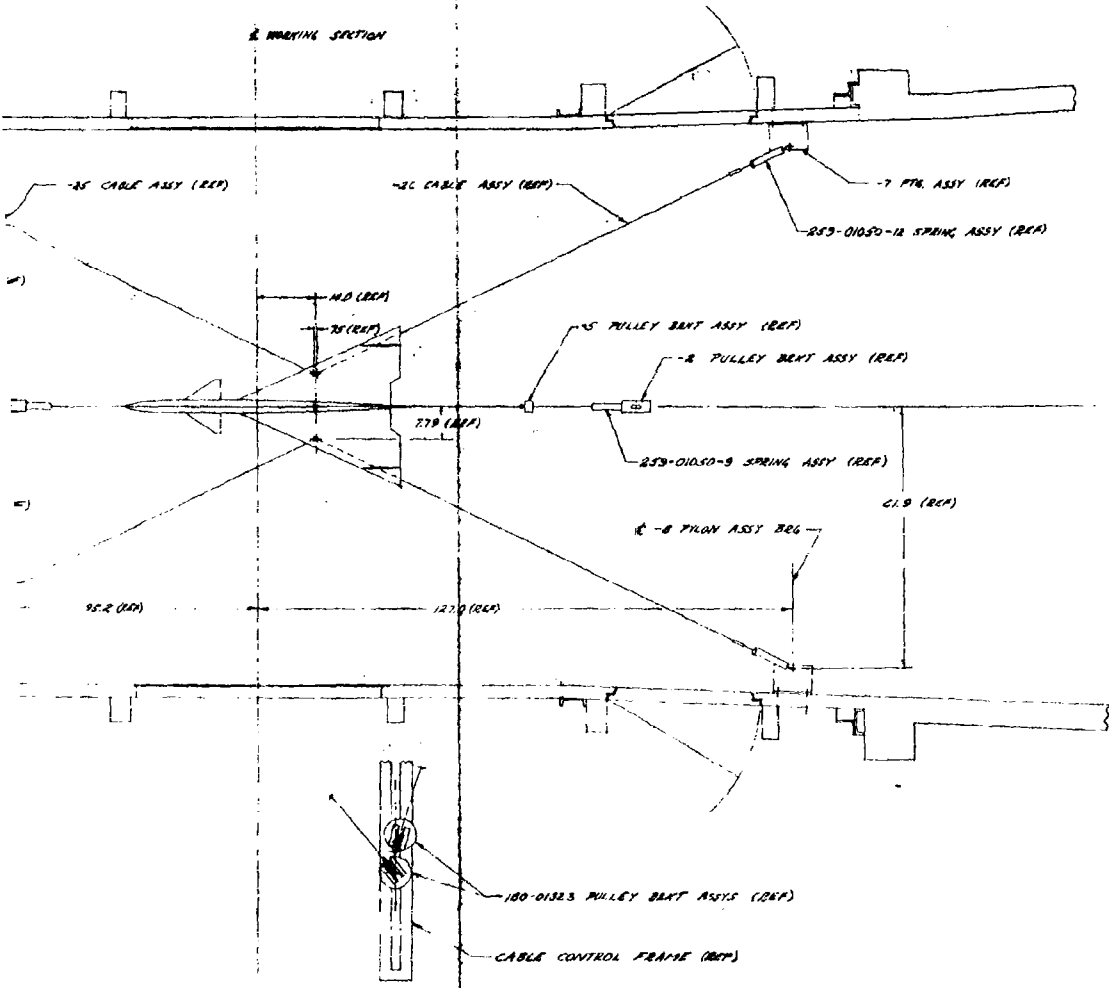
SPACER - 16 REQ (REF DETAIL)



ANS-10 BOLT (DE EDWIN)  
AN-10-1022 NUT (DE)  
WASHER, 31 0.25 X 0.06  
PART 11 BOST AL ALL

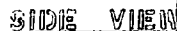
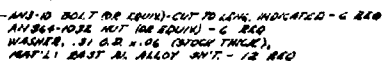
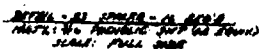
DETAIL E  
SCALE: FULL SIZE

MARKING SECTION



PLAN VIEW  
SCALE: 1" = 1' 0"

8



Slope: 1' = 1'0"

NOTE:  
SEE NEW F-P FOR PG ANGLE ON  
LOWER CABLES

9



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DATE: 11-30-59		MODEL NO. XB-70

### .10 SCALE SUBSONIC VERTICAL STABILIZER

Various root stiffness magnitudes were investigated using a .10 scale spindle type vertical tail for the -172 configuration at sea level.

The model was constructed of solid styrofoam whose thickness at any point in the planform simulated full scale bending stiffness. The model was ballasted for sea level conditions.

The root stiffness in pitch and roll were simulated over a range of stiffnesses by means of springs. The roll spring consisted of a square shaft attached at one end to the lower portion of the vertical tail and free to be clamped at the other end so that the effective length of the spring could be varied. The yaw springs were sets of two coil springs, each set of the same spring constant, which attached to the lower part of the vertical tail.

The results of the flutter test and shake test are shown on Figure 2. For any given roll stiffness, an increase in pitch stiffness gave an increase in flutter speed; for a constant pitch stiffness, an increase in roll stiffness gave an increase in flutter speed. The pitch stiffness affects the flutter speed to a larger degree than the roll stiffness. For this vertical stabilizer configuration, a pitch stiffness greater than 20,200 in-lb/rad and a roll stiffness greater than 22,600 in-lb/rad are required to give a sufficiently high flutter speed.

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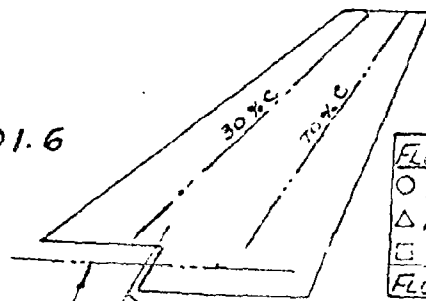
DATE

PITCH FLEXIBILITY  $\times 10^6$  - RAD/IN-LB

17.7

253

101.6

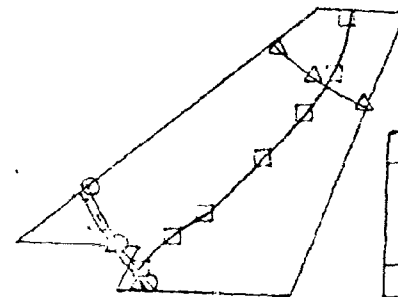


FLUTTER SPEED-MPH  
O 1<sup>ST</sup> BENDING  
Δ 2<sup>ND</sup> BENDING  
□ 1<sup>ST</sup> TORSION  
FLUTTER FREQ-CPM

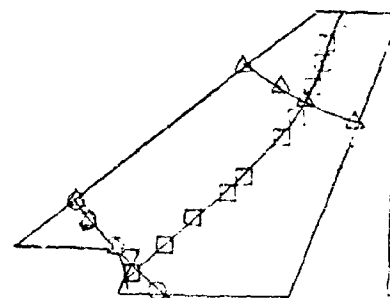
PITCH STIFFNESS AXIS

ROLL STIFFNESS AXIS

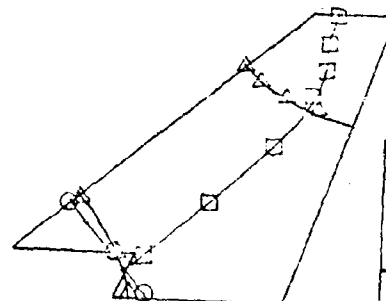
56.9



203
450
1615
2651
2220



204
518
1650
2685
2250



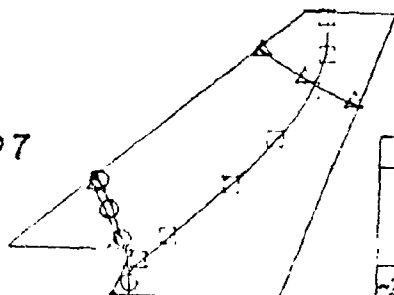
204
570
1710
2700
2240

31.4

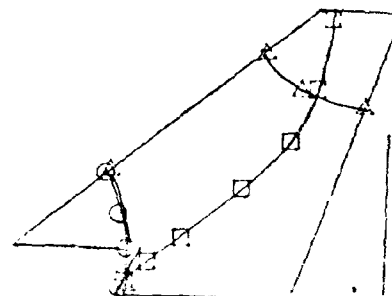
1

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6.07



206
690
1941
2931
2420



206
670
1864
2760
2300

ROLL FLEXIBILITY  $\times 10^6$  - RAD/IN-LB

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SHAKE TEST RESULTS

NA-59-1736

DATE: 9-18-58

.10 G VERTICAL

REPORT NO.

XB-70

MODEL NO.

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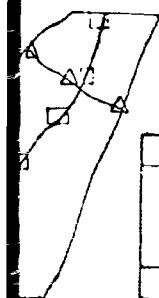
FIG 2

2

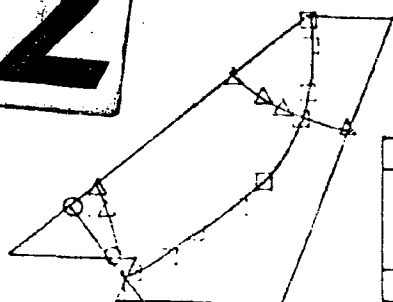
253

49.5

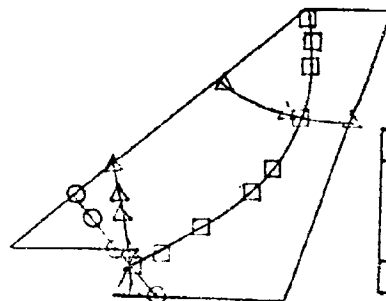
65.2



203
450
1615
2651
2220



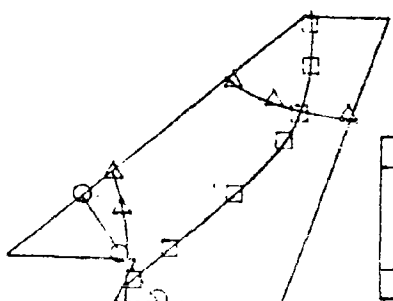
180
444
1571
2255
1920



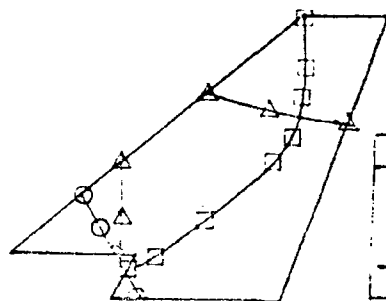
170
440
1534
2095
1865



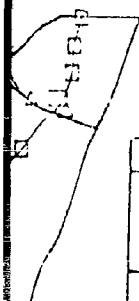
204
518
1650
2685
2250



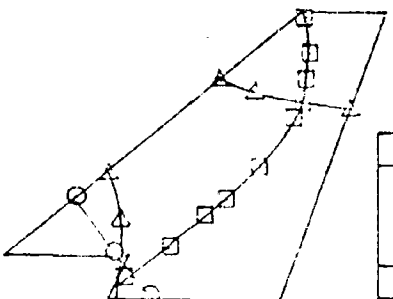
183
505
1598
2277
1920



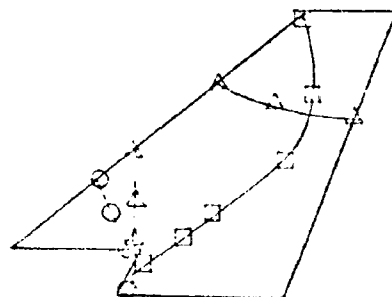
173
500
1546
2150
1850



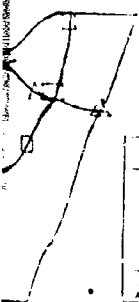
204
570
1710
2700
2240



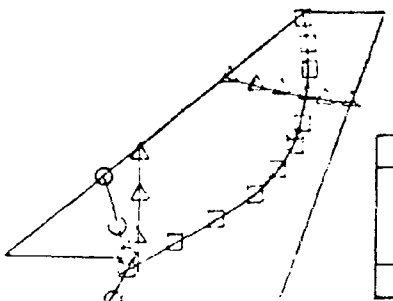
185
560
1628
2327
2030



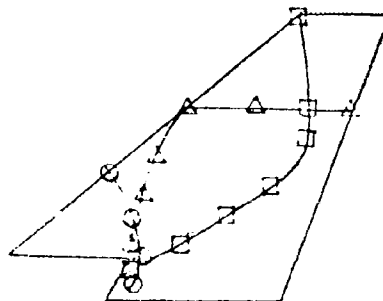
176
565
1578
2210
2030



206
670
1864
2760
2110



186
646
1696
2416
2140



183
638
1611
2316
2110

SECRET

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DATE: 11-30-59		MODEL NO. XB-70

.06 SCALE SUBSONIC VERTICAL STABILIZER

A styrofoam, .06 geometric scale and .233 speed scale, cantilevered model of the -172 configuration of the outboard vertical stabilizer was flutter tested in the WSC 7 3/4 x 11 foot low speed atmospheric wind tunnel. Shake test and flutter test results are shown on Figure 3.

No root flexibilities were simulated in the model. However, the flutter point obtained provided useful information on non-dimensional stiffness requirements for the planform.

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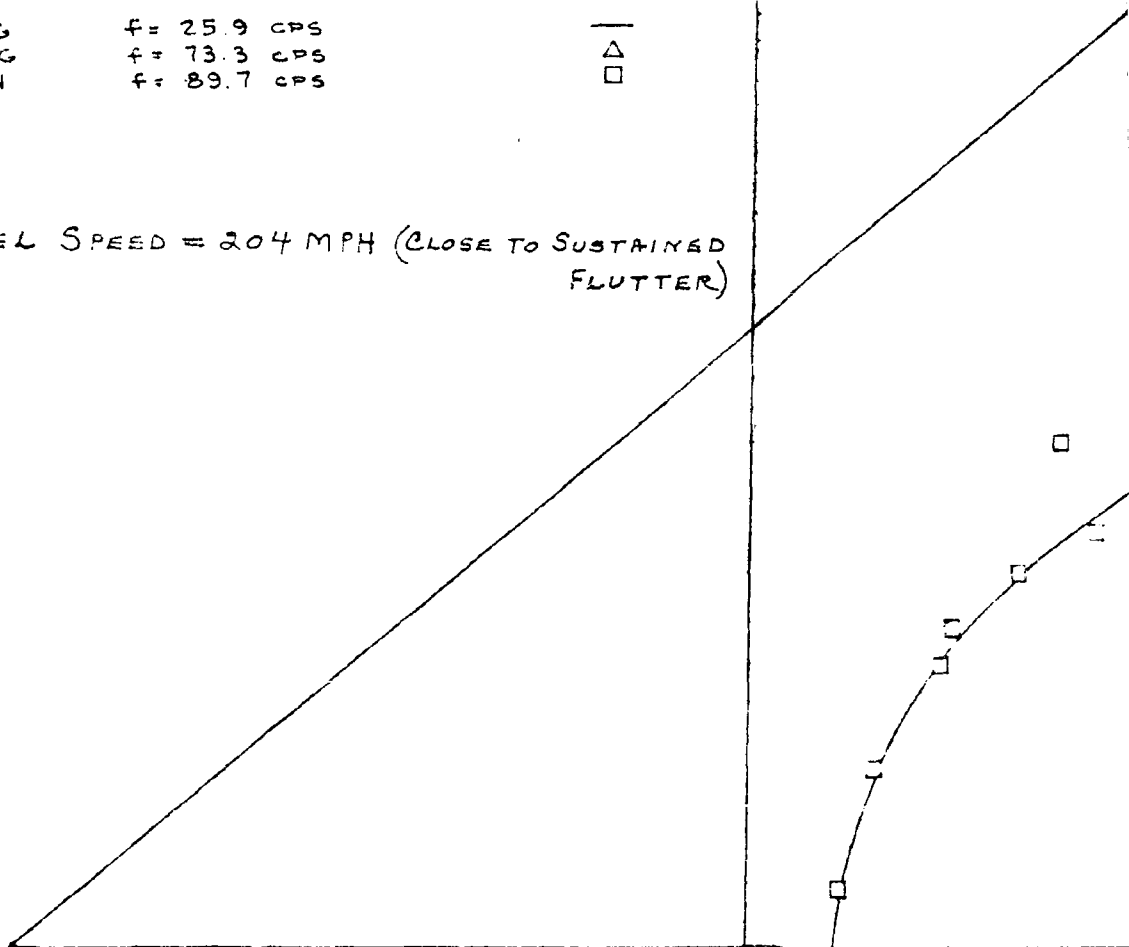
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CHECKED BY  
DATE 9

OUTBOARD VERTICAL STABILIZER  
.06 SCALE MODEL

MODE	FREQUENCY	NODE LINES
1ST BENDING	$f = 25.9$ CPS	—
2ND BENDING	$f = 73.3$ CPS	△
1ST TORSION	$f = 89.7$ CPS	□

MAX. TUNNEL SPEED = 204 MPH (CLOSE TO SUSTAINED FLUTTER)



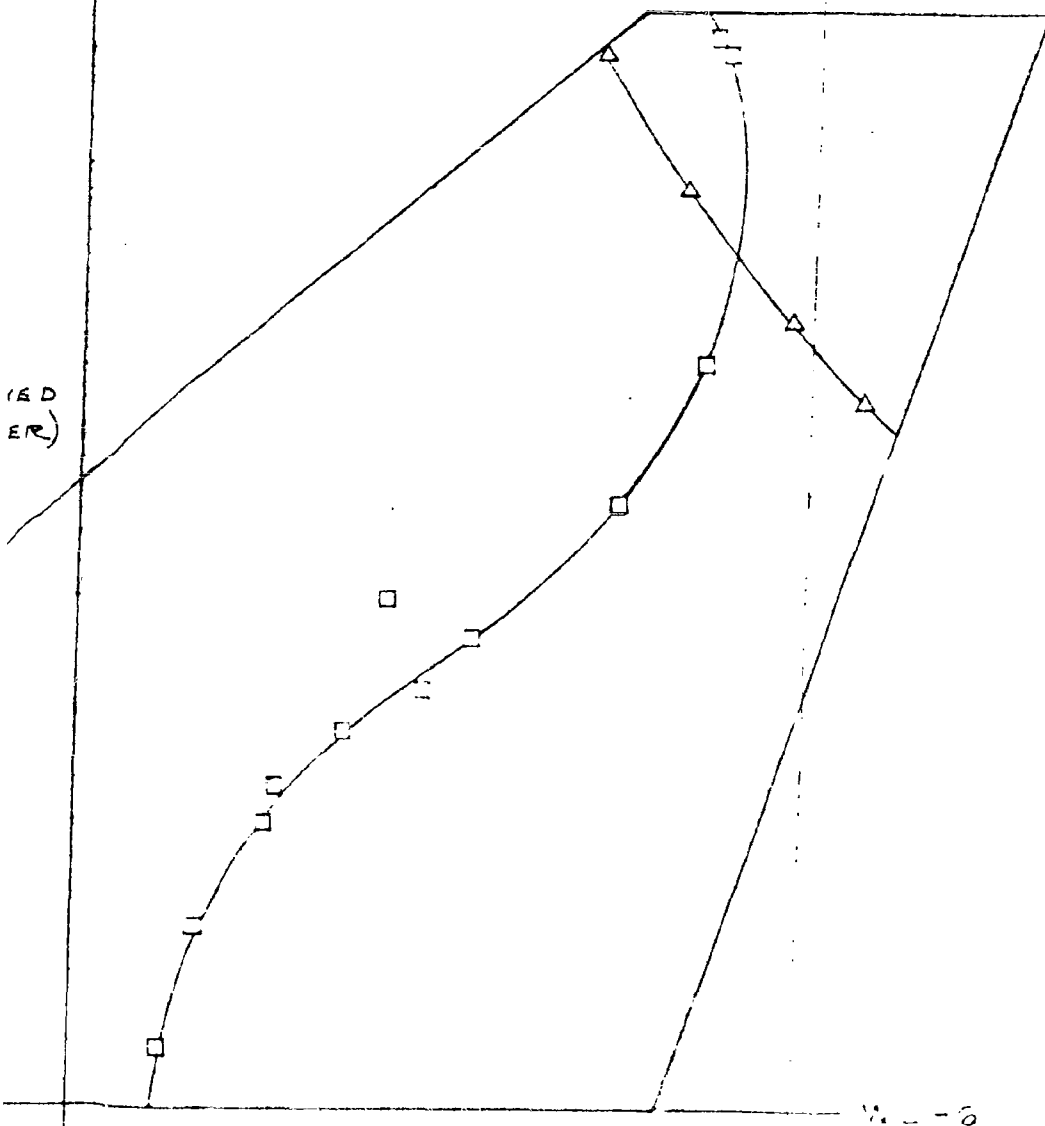
1

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PROJECT: MGH	ORGANIZATION: INC	DATE: 8 63
DESIGNER: J.R.S.	SECRET	NA-59-1736
DATE: 9-19-58		XB-70

FIG 3

R



2

FS 2275

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NO SCALE

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		MODEL NO. XB-70

.06 SCALE SUBSONIC WING II WITH OUTBOARD VERTICAL

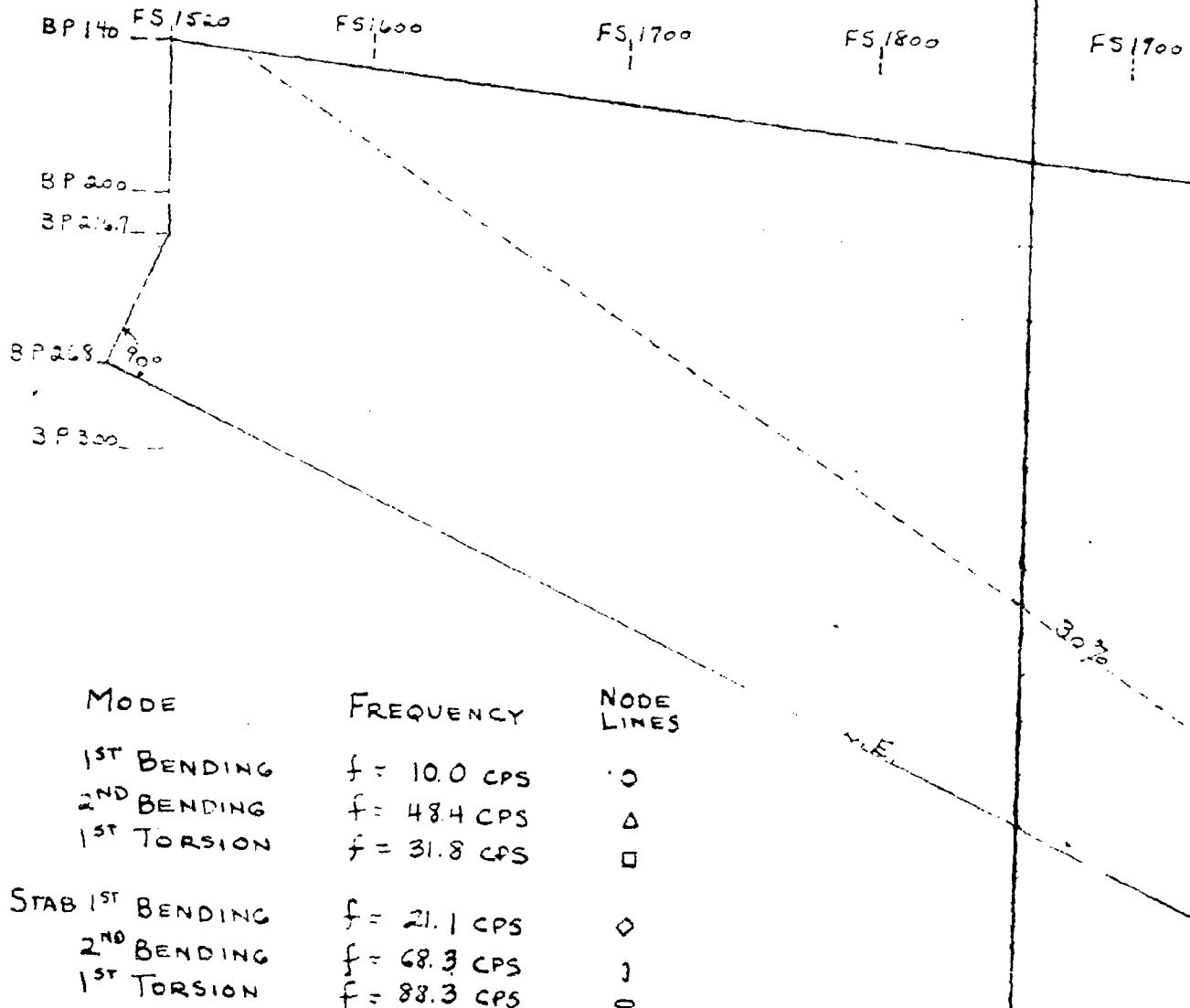
To investigate the interaction of wing and the vertical tail, a model simulating the -172 configuration was flutter tested in the WSC 7 3/4 x 11 foot low speed atmospheric wind tunnel.

The cantilever mounted styrofoam model of .06 geometric scale and a speed scale .233, was tested with the wing empty and full of fuel. Before each of the actual flutter tests, a shake test was conducted to determine natural frequencies and mode lines. The results of these tests are shown on Figure 4 through Figure 8. From the flutter tests of the model, it may be concluded that the empty wing has a lower flutter speed than the full wing. Comparing the results of this test with those on the vertical stabilizer only, the flutter mode encountered was primarily a wing mode rather than a vertical stabilizer mode.

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MODE	FREQUENCY	NODE LINES
1 <sup>ST</sup> BENDING	$f = 10.0$ CPS	0
2 <sup>ND</sup> BENDING	$f = 48.4$ CPS	Δ
1 <sup>ST</sup> TORSION	$f = 31.8$ CPS	□
STAB 1 <sup>ST</sup> BENDING	$f = 21.1$ CPS	◇
2 <sup>ND</sup> BENDING	$f = 68.3$ CPS	∩
1 <sup>ST</sup> TORSION	$f = 88.3$ CPS	0

VERTICAL STAB

MAX TUNNEL SPEED = 185 MPH (CLOSE TO SUSTAINED FLUTTER)

SCALE 100

WING LE START POINT  $f = 10$  FS 1520

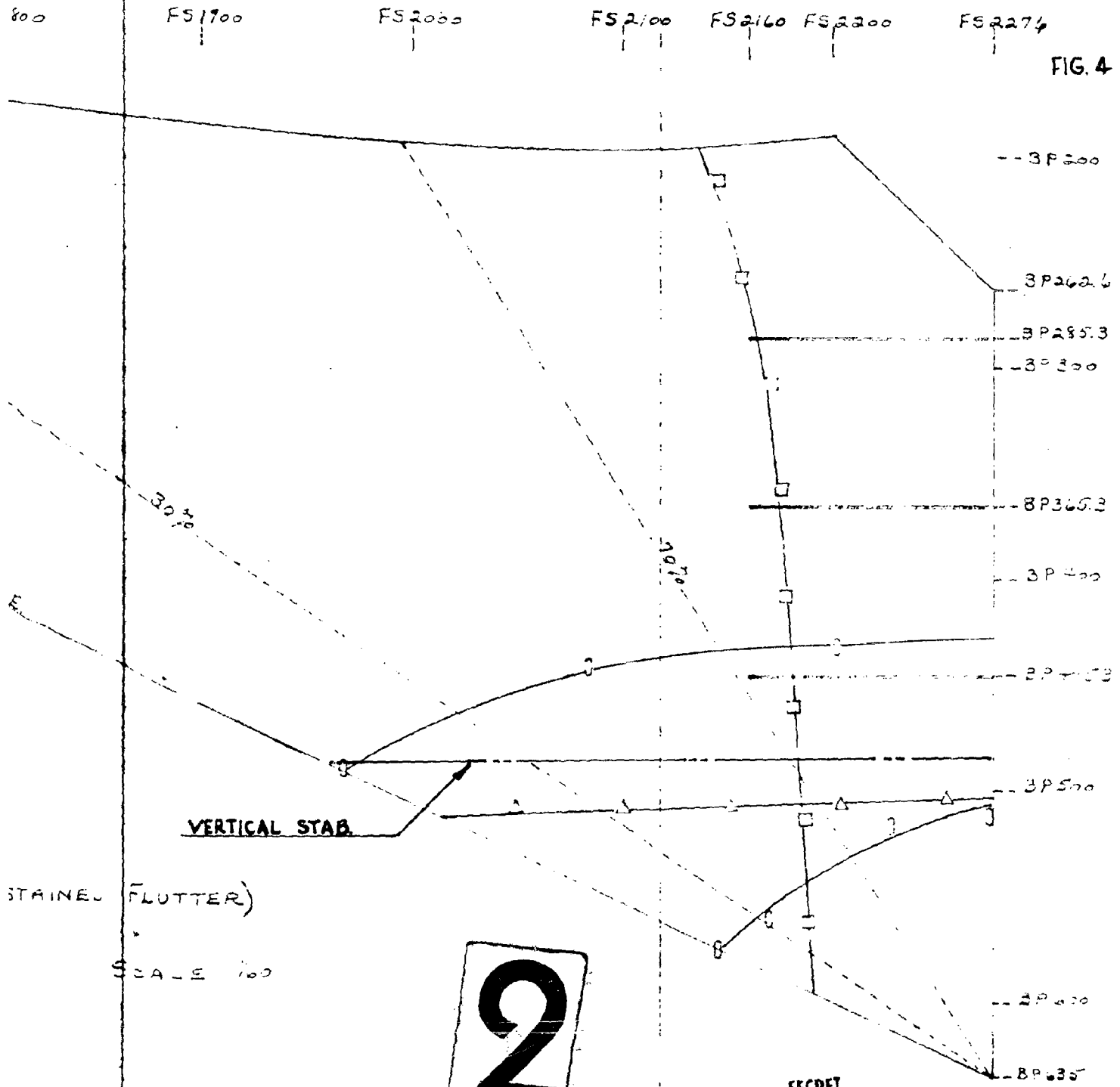
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1

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PREPARED BY: V.L.S.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 10 OF 63
CHECKED BY: J.R.S.	SHAKE TEST RESULTS	NA-59-1736
DATE: 5-22-58	06 WING #2 WITH OUTB'D VERT EMPTY FUEL	MODE. NO. XB 70

FIG. 4



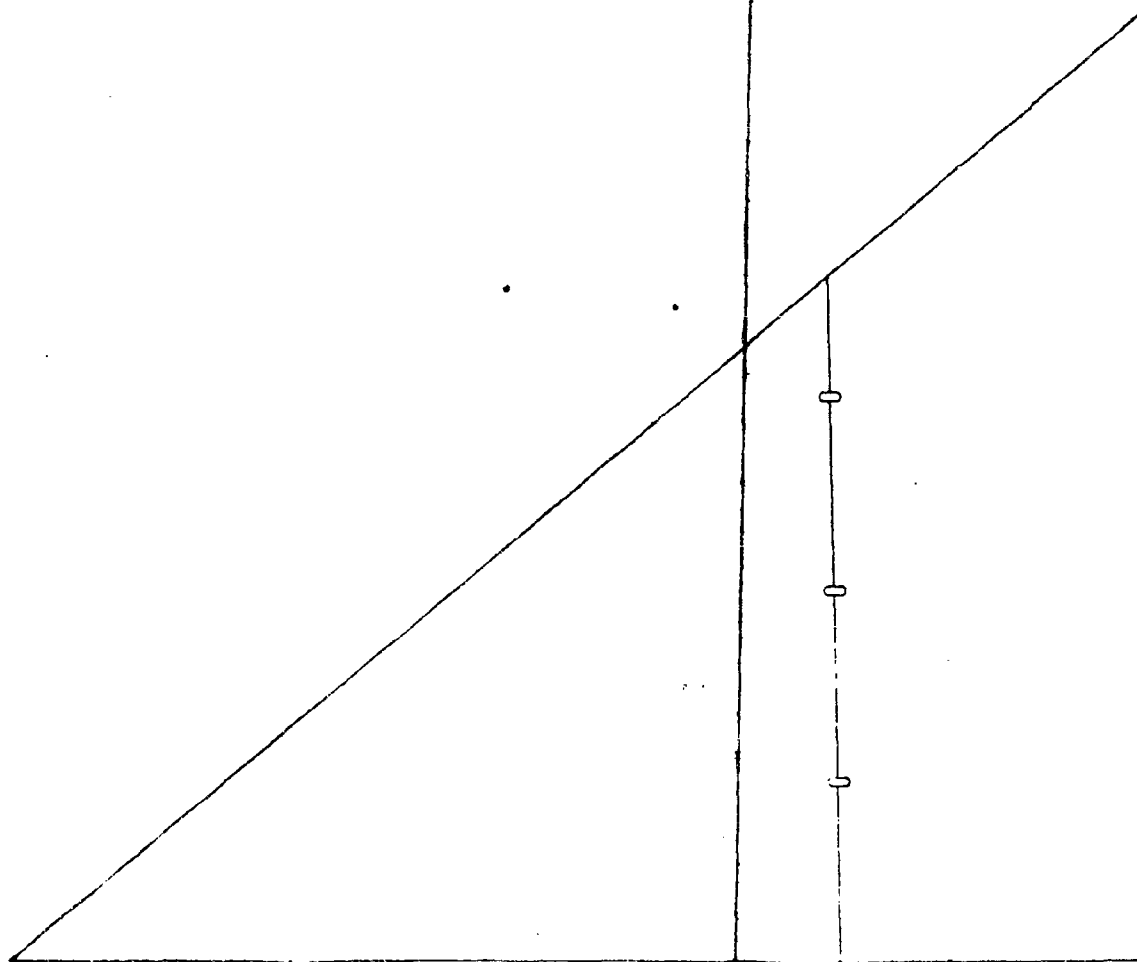
SECRET

PREPARED BY

DATE PREPARED J

9-1

1

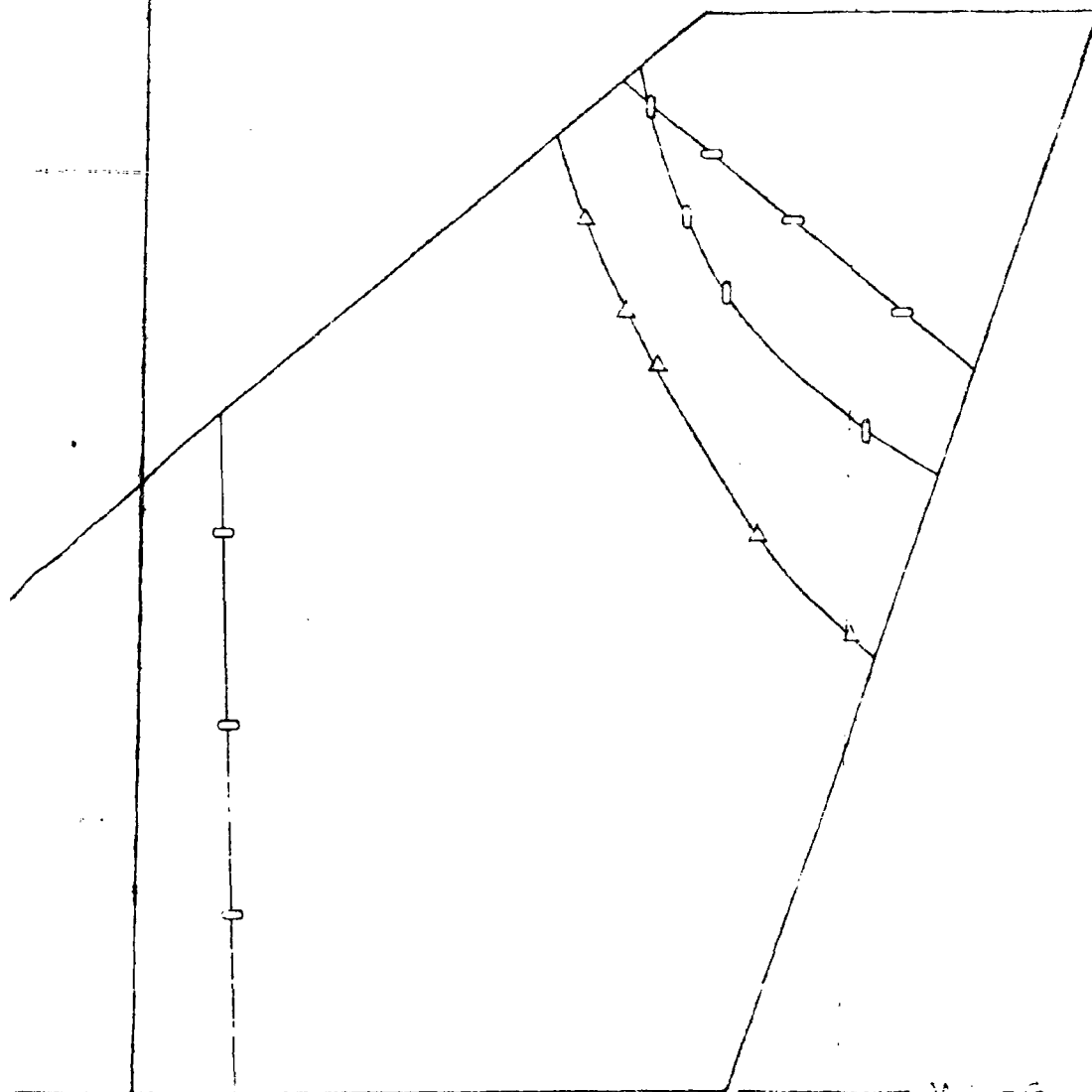


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DESIGNED BY	J.R.S.	SHAKE TEST RESULTS	NA-59-1736
DATE	9-19-58	.06 WING *2' W/ OUTBOARD VERT. STAB. EMPTY WING FUEL	XB-70

FIG 5



2

W. L. - 6

FS. 2275

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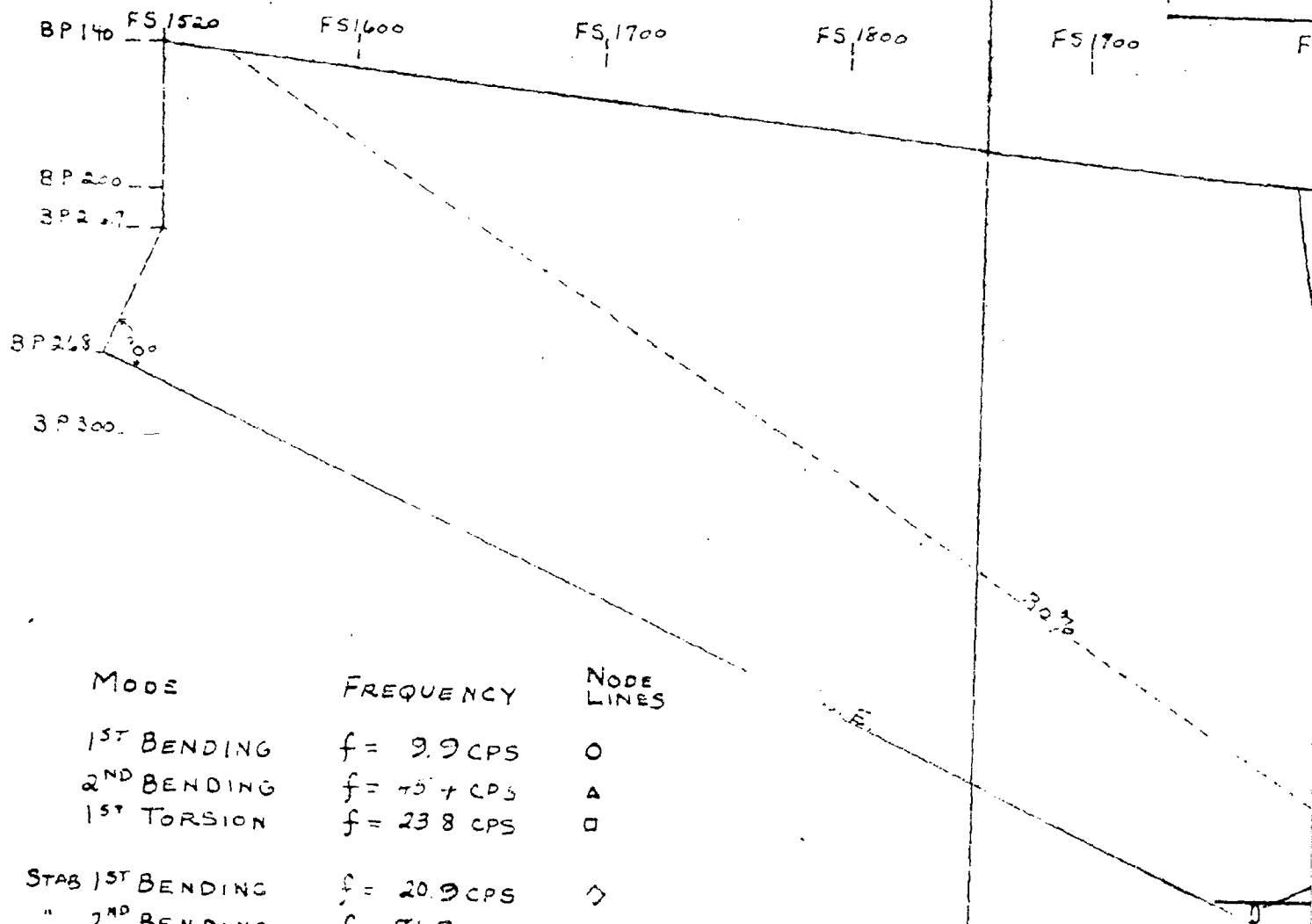
/40 600-1

SECRET

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CHECKED BY: J

DATE: 5-25



MODE	FREQUENCY	NODE LINES
1 <sup>ST</sup> BENDING	$f = 9.9 \text{ CPS}$	0
2 <sup>ND</sup> BENDING	$f = 75.4 \text{ CPS}$	A
1 <sup>ST</sup> TORSION	$f = 23.8 \text{ CPS}$	0
STAB 1 <sup>ST</sup> BENDING	$f = 20.9 \text{ CPS}$	0
" 2 <sup>ND</sup> BENDING	$f = 71.9 \text{ CPS}$	0
" 1 <sup>ST</sup> TORSION	$f = 84.9 \text{ CPS}$	0

MAX. TUNNEL SPEED = 192 MPH (CLOSE TO SUSTAINED FLUTTER)

VERTICAL S

SCALE 1/100

WING L = 1.0 METER,  $A_p = 0.1$  FS 92.5

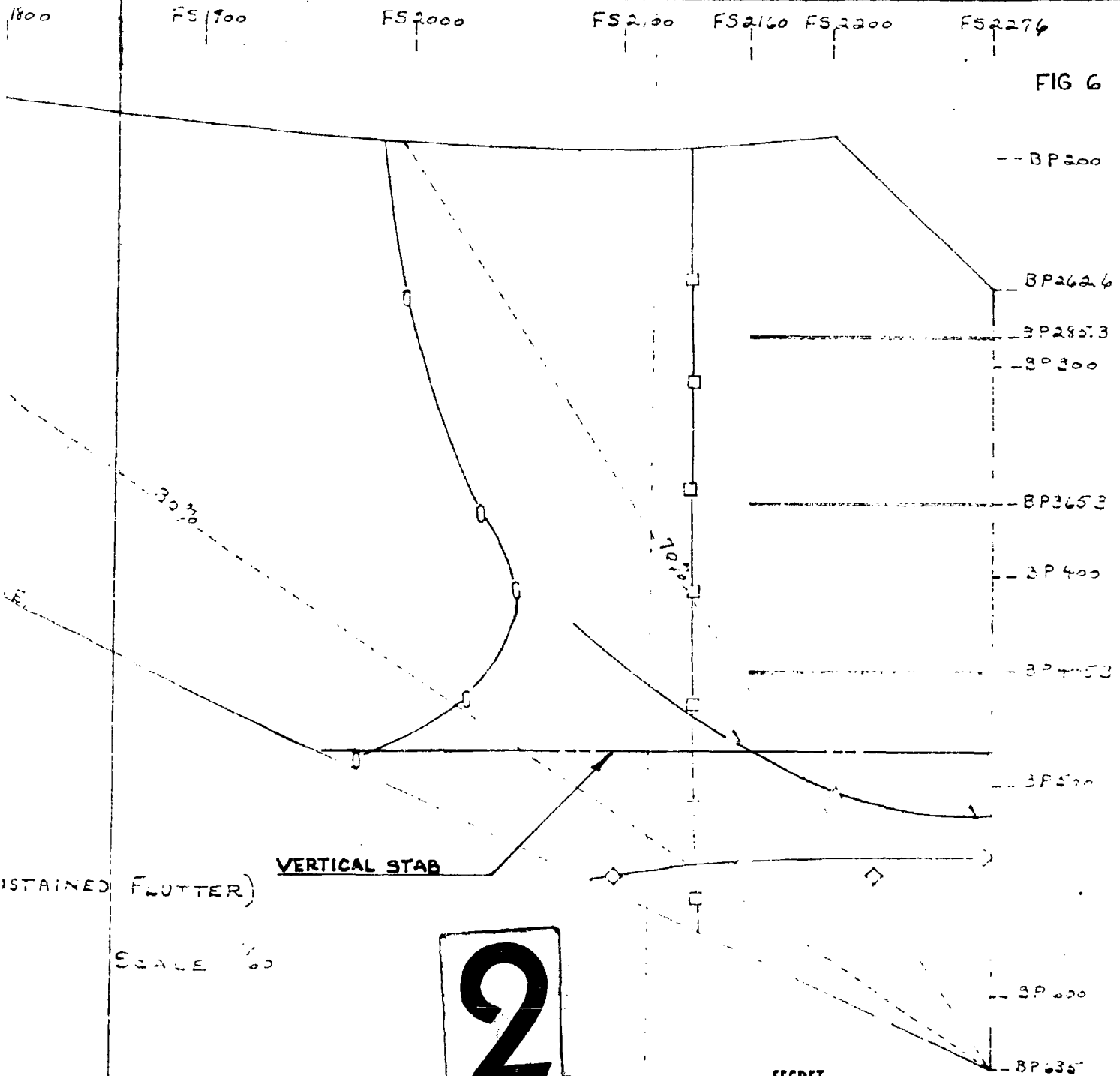
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1

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DATE: 5-22-58	06 WING #2 WITH OUTB'D VERT FULL FUEL	MODEL NO. XB 70

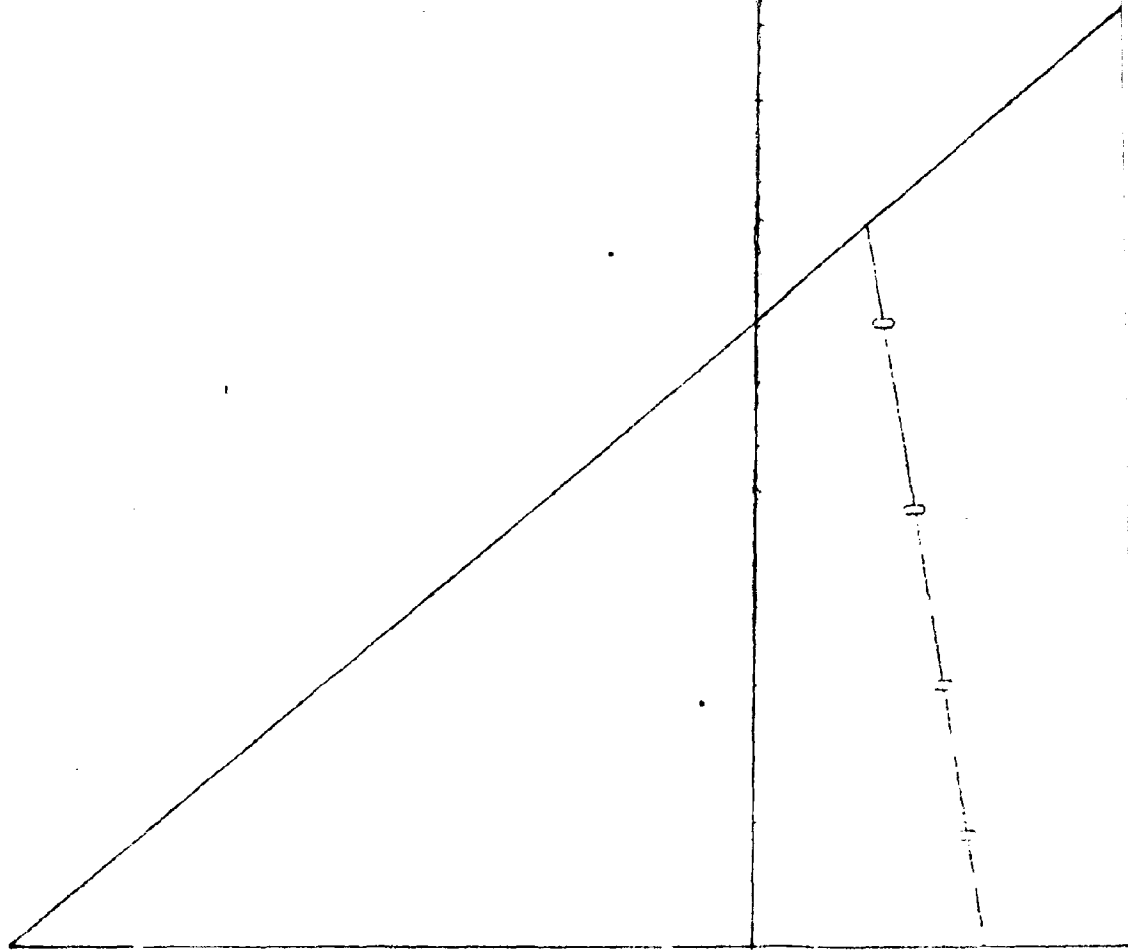
FIG 6



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1

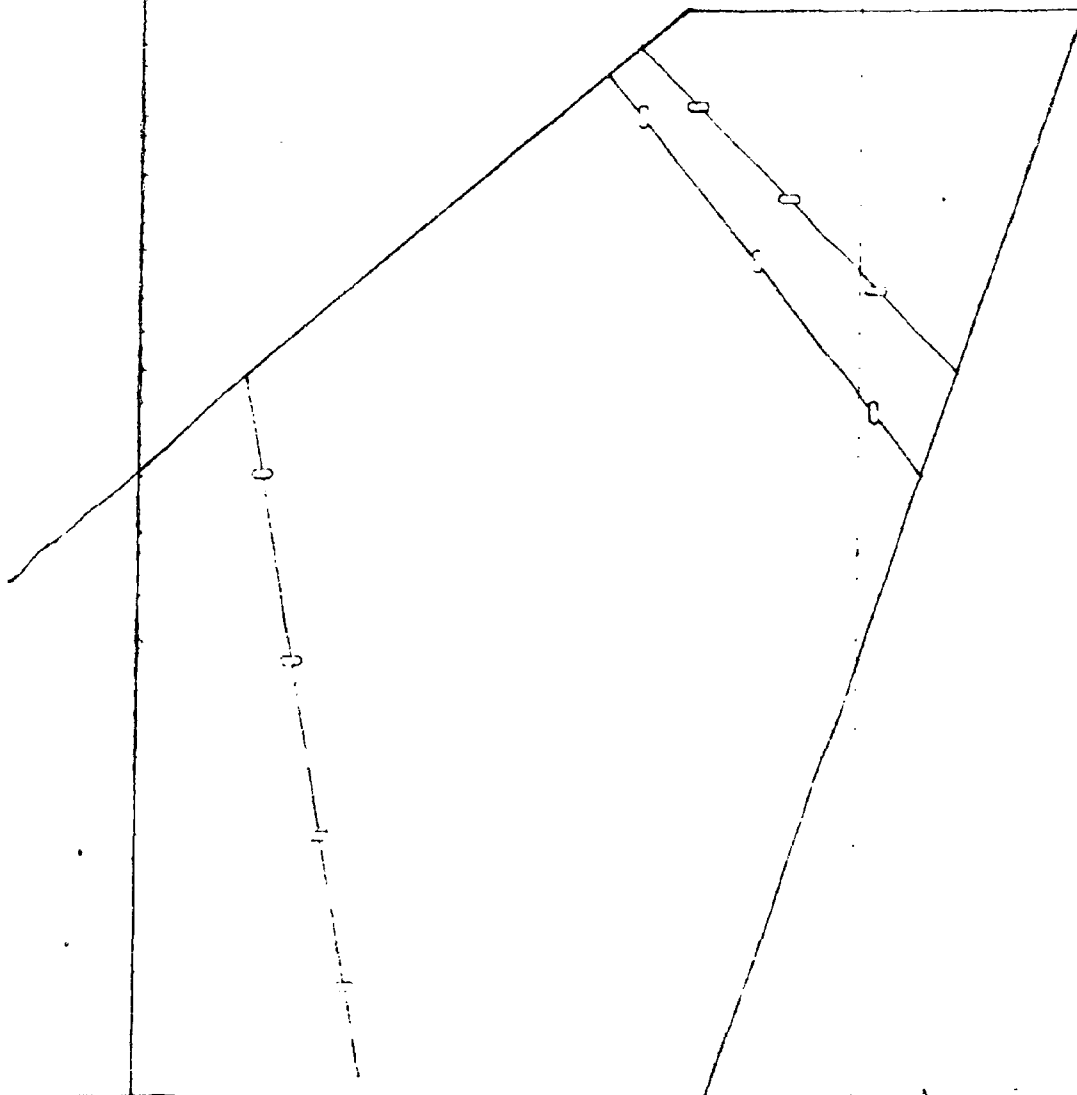


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SECRET

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..... J.R.S.	SHAKE TEST RESULTS	NA-59-1736
9-19-58	OG WING #2 WITHOUTBOARD VERT. STAB.	..... XB-70
FULL WING FUEL		

FIG. 7



2

FS. 2275

1/40 SCALE

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		MODEL NO.

FIG 8

# FLUTTER SPEED COMPARISON WING #2 WITH AND WITHOUT VERT.

FLUTTER SPEED-MPH			
WITH VERT. STAB		WITHOUT VERT STAB	
FUEL LOADING		FUEL LOADING	
EMPTY	FULL	EMPTY	FULL
185	192	181	

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### .06 SCALE SUBSONIC WING I

Various fuel and ballast loadings were investigated using a .06 scale model of the wing cantilever mounted. The fuel loadings tested were; level, forward, aft, outboard, and inboard for 0, 25, 50, 75 and 100 per cent of full fuel load.

The model was constructed of solid styrofoam scaled to a .06 geometric scale and a .233 speed scale. Holes were drilled into the styrofoam so that the weights appropriate to the loading condition could be inserted. The model was cantilevered from the floor of the WSC 7 3/4 x 11 foot, low speed, atmospheric wind tunnel. A shake test of each condition was conducted prior to flutter testing.

After the flutter test was completed on all loading conditions of interest attempts were made to obtain destructive flutter for the critical points. The tip of the model was broken off in the empty condition while raising the flutter speed from 175 to 182 mph. The flutter was primarily of second bending type. These tests show a general trend of the flutter speed to increase with increase in fuel loading.

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DATE <b>10-16-58</b>		MODEL NO <b>XB-70</b>

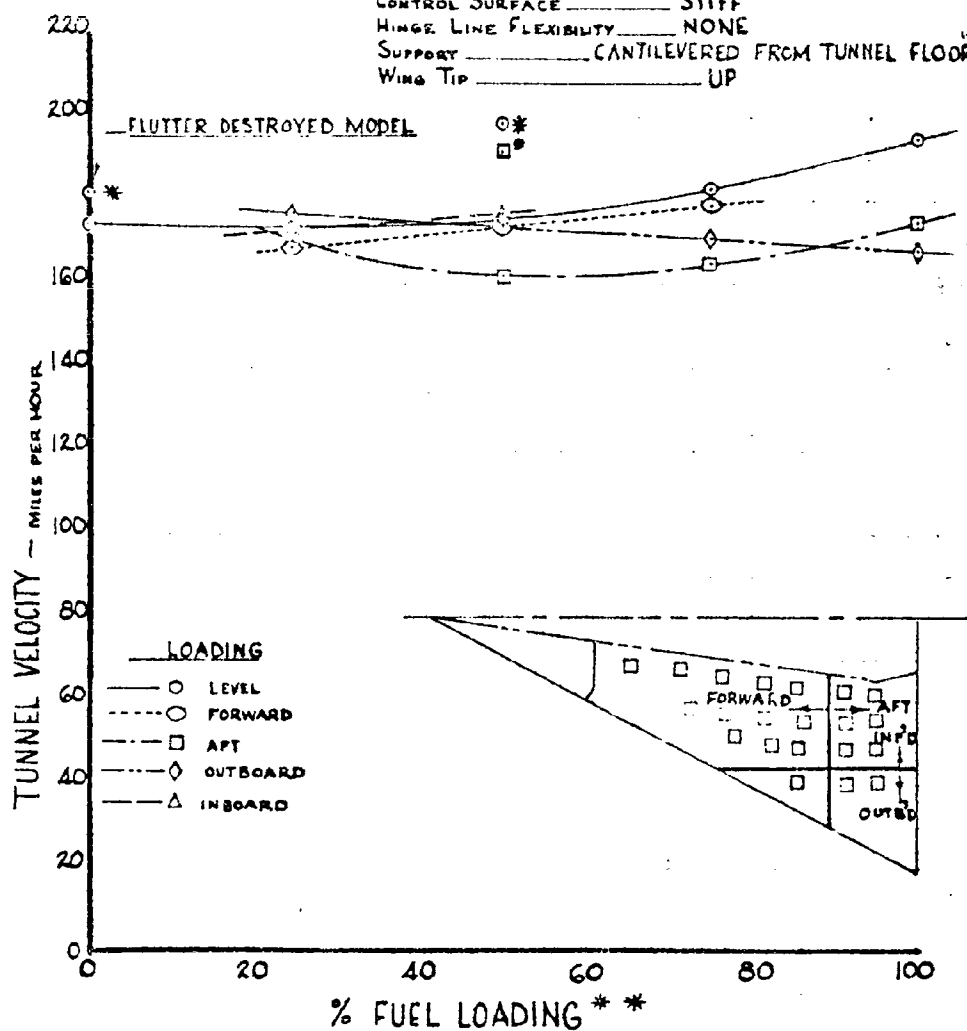
FIG 9

# FLUTTER SPEED vs WING FUEL LOADING

B-70 WING #1 NAAL TEST #429

## MODEL CHARACTERISTICS:

GEOMETRIC SCALE \_\_\_\_\_ .06  
 MATERIAL \_\_\_\_\_ SOLID STYROFOAM  
 SPEED SCALE \_\_\_\_\_ .233  
 ALTITUDE \_\_\_\_\_ SEA LEVEL  
 CONTROL SURFACE \_\_\_\_\_ STIFF  
 HINGE LINE FLEXIBILITY \_\_\_\_\_ NONE  
 SUPPORT \_\_\_\_\_ CANTILEVERED FROM TUNNEL FLOOR  
 WING TIP \_\_\_\_\_ UP



\* ATTEMPTS TO OBTAIN DESTRUCTIVE FLUTTER, ALL OTHER POINTS APPEARED VERY CLOSE TO SUSTAINED FLUTTER.

\*\* PER CENT OF FUEL LOADING REFERS TO % OF FULL FUEL LOAD FOR LEVEL FUEL LOADING IN AREAS DEFINED BY SKETCH,

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DATE: 11-30-59		MODEL NO. XB-70

# B-70 WING NAAL TEST #429

FIG 10

## MODEL CHARACTERISTICS

GEOMETRIC SCALE ..... .06	CONTROL SURFACE ..... STIFF
SPEED SCALE ..... .233	HINGE LINE FLEXIBILITY ..... NONE
MATERIAL ..... STYROFOAM	SUPPORT ..... CART FROM TUNNEL FLOOR
ALTITUDE ..... SEA LEVEL	WING TIP ..... UP
	FUEL LOADING ..... VARIABLE

## SUMMARY OF TEST RESULTS

RUN NO	FUEL	LOADING				MAX TUNNEL SPEED MPH	SHAKE TEST FREQUENCIES - cps				
		LEVEL	FORWARD	AFT	OUTBD		INBD	f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>
1	EMPTY	✓					168	12.8	32.0	45.8	72.8
2	FULL	✓					192	12.4	23.9	37.5	49.6
3 1/4	FULL		✓			✓	181	13.0	29.8	39.1	68.0
5	FULL			✓			175	12.3	25.9	44.5	69.2
6	3/4			✓			165	13.2	29.6	48.5	74.9
7 1/8	3/4	✓					180	11.8	26.8	42.3	54.8
9	1/2	✓					176	13.4	29.0	44.2	69.3
10	1/2			✓			162	13.2	30.8	48.7	75.3
11	1/4			✓			171	13.8	32.9	49.1	76.6
12	1/4	✓					174	12.7	29.3	43.5	64.5
13	FULL				✓		168	12.1	25.8	41.7	60.2
14	3/4				✓		171	13.6	29.6	46.6	67.3
15	1/4		✓				169	13.8	34.1	47.9	72.3
16*	1/2			✓			165	11.7	27.8	44	68.3
17	1/2	✓	[ONE WT LOCATION HAD 1/4 WT]				177	12.6	26.4	41.1	66.8
18	3/4		✓				179	12.6	29.0	39.8	49.6
19	1/2		✓				174	12.1	30.2	41.6	63.7
20	1/2					✓	177	12.1	29.8	42.5	63.3
21	1/4					✓	173	12.1	30.7	44.2	66.0
22	1/4				✓		177	13.3	33.3	48.9	74.4
23*	1/2			✓			173	12.3	27.8	43.5	65.2
24*	1/2			✓			181	12.2	27.6	43.9	66.4
25*	1/2			✓			178	12.1	27.1	43.2	68.2
26**	1/2			✓			192	SAME AS RUN #10			
27*	1/2	✓					199	SAME AS RUN #9			
28*	EMPTY	✓					182	SAME AS RUN #1			

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### .06 SCALE SUBSONIC WING II

Required stiffness levels were investigated at sea level, 15,000 feet, and 30,000 feet for various hinge rotational stiffness levels at 60% and 79% wing semi-span.

The .06 geometric scale model with a speed scale of .233 was constructed of solid styrofoam. At the 60% and 79% semi-span positions, rotational springs of the following stiffnesses were installed:

	Stiffness in in-lb/rad x 10 <sup>-4</sup>				
	10%	25%	50%	75%	100%
60% Fold Line	.311	.781	1.561	2.342	3.112
79% Fold Line		.1201	.2401	.3602	.4802

The model was ballasted for the empty sea level condition. To simulate altitude, incremental ballast was added to the empty sea level model. While the stiffness was being investigated at one hinge position, the other hinge was maintained at the 100% stiffness level. The 100% stiffness level corresponds to that existing if the structure were continuous across the hinge.

The natural frequencies and mode lines of the first three or four modes were determined before actual flutter testing the model in the WSC 7 3/4 x 11 foot low speed atmospheric wind tunnel at sea level density. The flutter margin was shown to be adequate in all runs, with the flutter speed being relatively insensitive to fold stiffness, fold position, or tip deflection, and increasing with altitude more rapidly than a constant  $q$ .

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DATE: 11-30-59	SECRET	REPORT NO
		MODEL NO XB-70

# B-70 WING NAAL TEST #430

FIG 11

## MODEL CHARACTERISTICS

GEOMETRIC SCALE..... .06  
SPEED SCALE..... .238  
MATERIAL..... STYROFOAM  
ALTITUDE..... VARIABLE

CONTROL SURFACE..... STIFF  
HINGE LINE STIFFNESS..... VARIABLE  
SUPPORT... CANT. FROM TUNNEL FLOOR  
WING TIP DEFLECTION..... VARIABLE  
FUEL LOADING..... EMPTY

## SUMMARY OF TEST RESULTS

RUN NO	ALT. FT.	STIFF LEVEL		DEFLECT ~ °		MAX TUNNEL SPEED MPH.	SHAKE TEST FREQUENCIES - CPS			
		60% 1/2	75% 1/2	60% 1/2	75% 1/2		f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>
1	S.L.	100	100	0	0	169	10.5	31.3	47.0	—
2	S.L.	100	100	0	45	190	9.8	30.2	44.2	60.7
3	S.L.	100	100	0	75	200	11.0	33.3	47.4	66.8
4	S.L.	100	100	25	0	196	9.9	29.7	40.6	59.0
5	S.L.	100	100	52	0	202	11.5	29.0	39.4	61.3
6	S.L.	100	75	0	0	204	9.8	28.5	41.5	58.8
7	S.L.	100	50	0	0	198	9.8	31.3	45.0	64.4
8	S.L.	100	25	0	0	185	10.7	30.6	44.5	65.1
9*	S.L.	100	100	0	0	181	10.5	31.3	47.0	—
10	S.L.	75	100	0	0	199	10.6	31.6	46.2	65.4
11	S.L.	50	100	0	0	192	9.5	29.3	42.6	60.1
12	S.L.	25	100	0	0	180	9.4	28.8	41.2	58.7
13	S.L.	25	100	25	0	188	10.8	32.8	42.8	64.1
14	S.L.	25	100	52	0	184	10.3	25.8	35.1	54.8
15	15,000	100	100	0	0	203	7.6	23.3	33.4	48.5
16	15,000	25	100	0	0	202	8.2	25.4	36.2	52.0
17	30,000	25	100	0	0	202	6.3	19.7	28.0	—
18	30,000	100	100	0	0	205	6.3	19.6	28.2	—

\* RERUN #1

SECRET

PREPARED BY	AJE	NORTH AMERICAN AVIATION, INC.	PAGE NO. 20 OF 63
CHECKED BY	J.R.S.	SECRET	NA-59-1736
DATE	10-24-58		REPORT NO.
			MODEL NO. XB-70

FIG 12

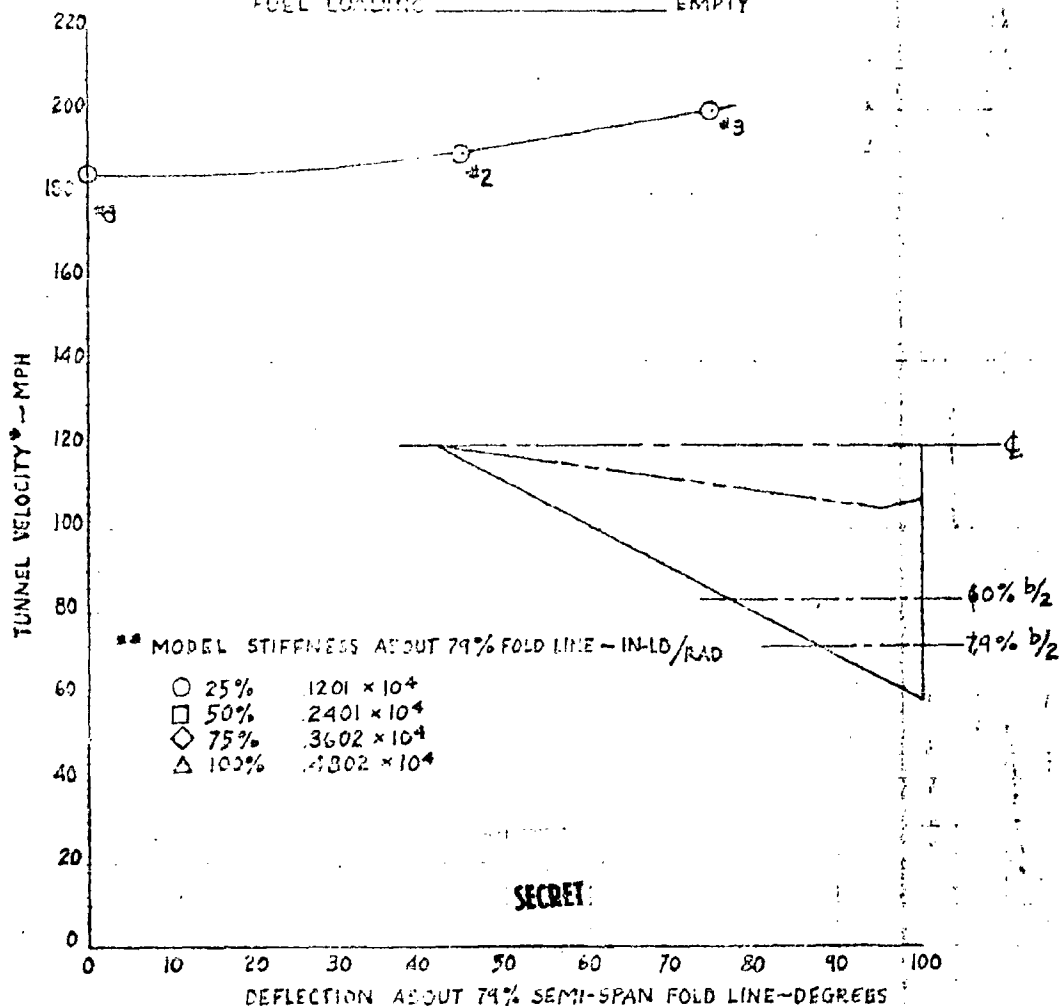
# VARIATION OF FLUTTER SPEED WITH DEFLECTION

## ABOUT 75% SEMI-SPAN FOLD LINE

B-70 WING #2 NAAL TEST #430

### MODEL CHARACTERISTICS:

GEOMETRIC SCALE ————— .06  
 MATERIAL ————— SOLID STYROFOAM  
 SPEED SCALE ————— .233  
 ALTITUDE ————— SEA LEVEL  
 CONTROL SURFACE ————— STIFF  
 HINGE LINE STIFFNESS ————— \*  
 SUPPORT ————— CANTILEVERED FROM TUNNEL FLOOR  
 WING TIP DEFLECTION ————— SEE PLOT  
 FUEL LOADING ————— EMPTY



\* ALL POINTS APPEARED CLOSE TO SUSTAINED FLUTTER, EXCEPT WHERE TUNNEL BRACKES REMOVED.  
 NUMBERS ADJACENT TO CIRCLED POINTS INDICATE NAAL TEST RUN NUMBERS.  
 STIFFNESS ABOUT 60% LINE MAINTAINED AT 100% OR  $3.112 \times 10^4$  IN-LB/RAD.

PREPARED BY <b>AJE</b>	NORTH AMERICAN AVIATION, INC.	PAGE NO. 21 of 63
CHECKED BY <b>J.R.S.</b>		NA-59-1736
DATE <b>10-24-54</b>		MODEL NO. <b>XB-70</b>

FIG 13

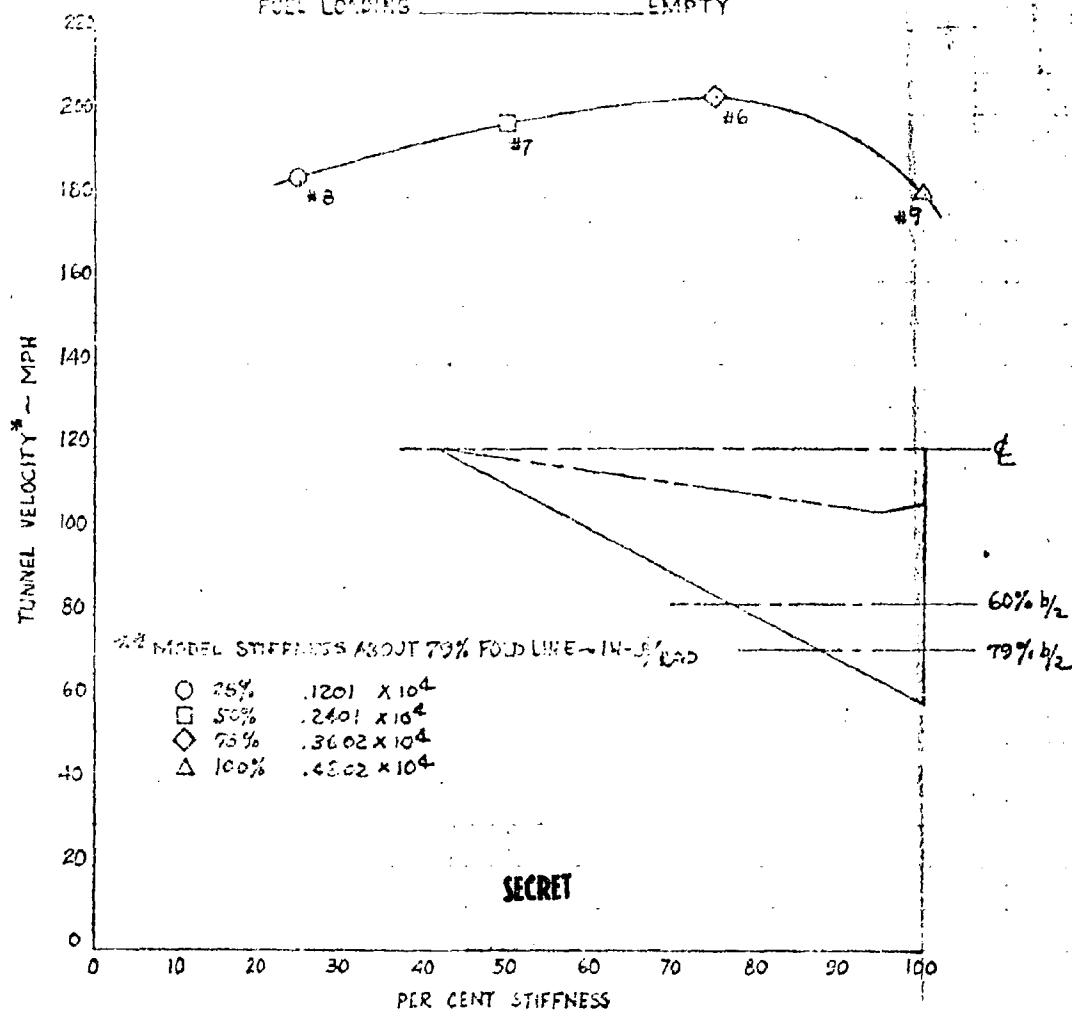
# VARIATION OF FLUTTER SPEED WITH STIFFNESS

## ABOUT 79% SEMI-SPAN FOLD LINE

B-70 WING #2 NAAL TEST #430

### MODEL CHARACTERISTICS:

GEOMETRIC SCALE ————— 06  
 MATERIAL ————— SOLID STYROFOAM  
 SPEED SCALE ————— .233  
 ALTITUDE ————— SEA LEVEL  
 CONTROL SURFACE ————— STIFF  
 HINGE LINE STIFFNESS ————— 1.2  
 SUPPORT ————— CANTILEVERED FROM TUNNEL FLOOR  
 WING TIP DEFLECTION ————— 0°  
 FUEL LOADING ————— EMPTY



\* ALL POINTS APPEARED CLOSE TO SUSTAINED FLUTTER, EXCEPT WHERE TUNNEL BRAKES REMOVED  
 NUMBERS ADJACENT TO CIRCLED POINTS INDICATE NAAL TEST RUN NUMBERS.  
 STIFFNESS ABOUT 60% LINE MAINTAINED AT 100% OR 3.112 x 10<sup>4</sup> IN-LB/RAD.

PREPARED BY: AJE	NAVAL AMERICAN AVIATION, INC.	PAGE NO. 22 OF 63
CHECKED BY: J.R.S.	SECRET	NA-59-1736
DATE: 10-24-58		REPORT NO. XB-70

FIG 1A

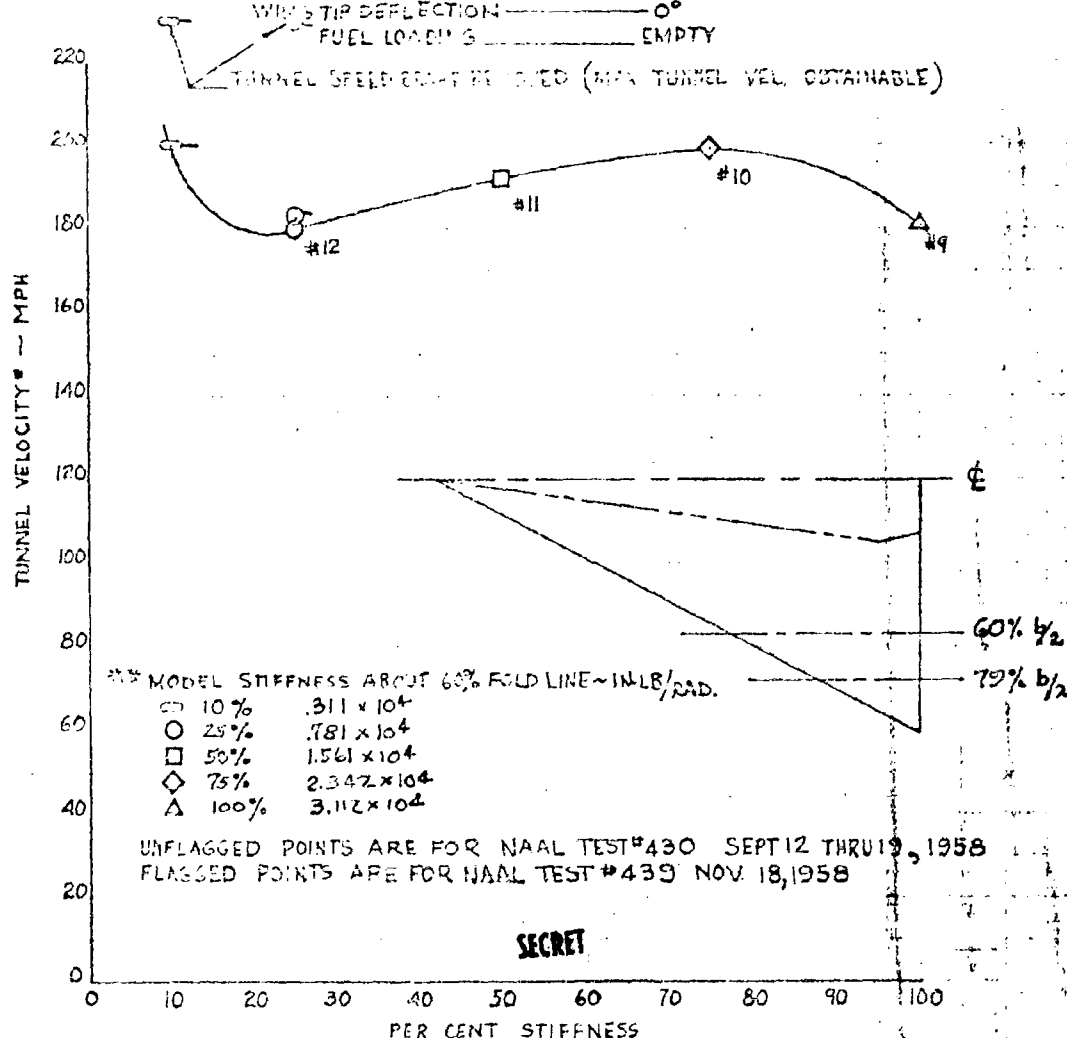
# VARIATION OF FLUTTER SPEED WITH STIFFNESS

## ABOUT 60% 50% H-SPAN FOLD LINE

B-70 WING \*Z NAAL TEST #430 & 439

### MODEL CHARACTERISTICS:

GEOMETRIC SCALE ————— .06  
 MATERIAL ————— SOLID STYROFOAM  
 SPEED SCALE ————— .233  
 ALTITUDE ————— SEA LEVEL  
 CONTROL SURFACE ————— STIFF  
 HINGE LINE STIFFNESS ————— \*  
 SUPPORT ————— CANTILEVERED FROM TUNNEL FLOOR  
 WING TIP DEFLECTION ————— 0°  
 FUEL LOADING ————— EMPTY



\* ALL POINTS APPEARED CLOSE TO SUSTAINED FLUTTER, EXCEPT WHERE TUNNEL BRAKES REMOVED  
 NUMBERS ADJACENT TO CIRCLED POINTS INDICATE NAAL TEST RUN NUMBERS.  
 STIFFNESS ABOUT 79% LINE MAINTAINED AT 100% OR  $.4802 \times 10^4$  IN-LB/RAD.

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CHECKED BY J.R.S.	SECRET	NA-59-1736
DATE 10-24-58		MODEL NO. XB-70

FIG 15

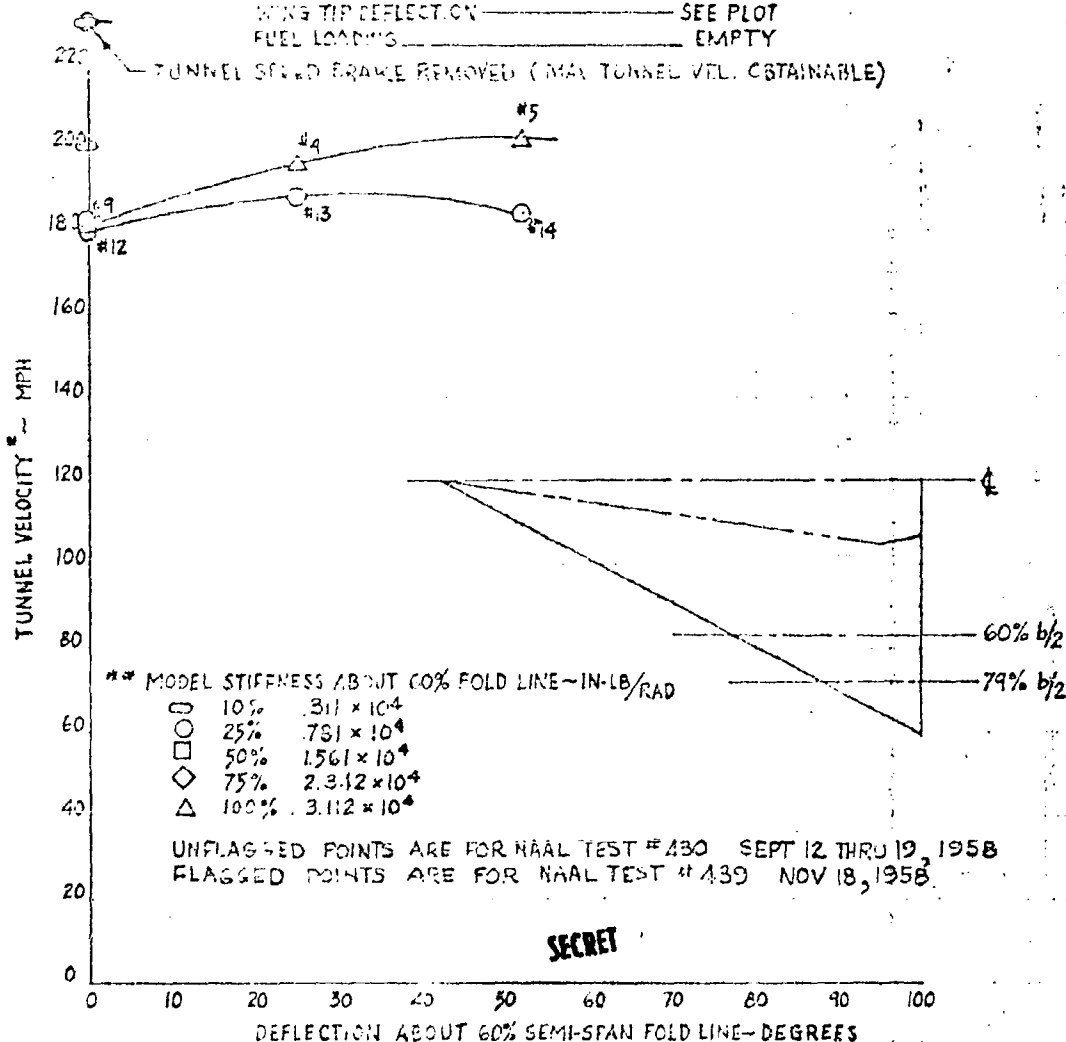
# VARIATION OF FLUTTER SPEED WITH DEFLECTION

## ABOUT 60% SEMI-SPAN FOLD LINE

B-70 WING #2 NAAL TEST #430 & 439

### MODEL CHARACTERISTICS:

GEOMETRIC SCALE ————— .06  
 MATERIAL ————— SOLID STYROFOAM  
 SPEED SCALE ————— 233  
 ALTITUDE ————— SEA LEVEL  
 CONTROL SURFACE ————— STIFF  
 HINGE LINE STIFFNESS ————— \*\*  
 SUPPORT ————— CANTILEVERED FROM TUNNEL FLOOR  
 WING TIP DEFLECTION ————— SEE PLOT  
 FUEL LOADING ————— EMPTY

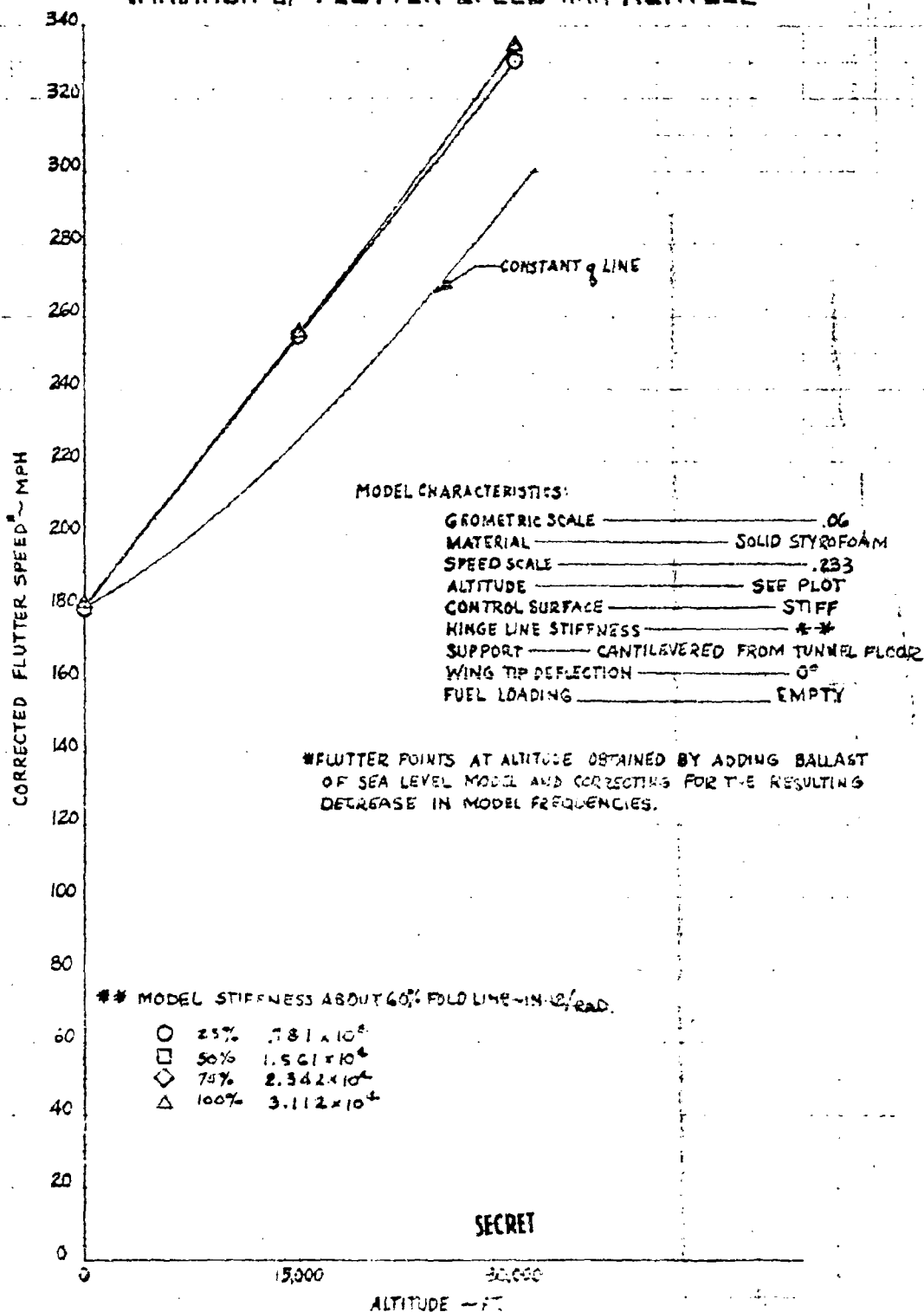


\* ALL POINTS APPEARED DUE TO SUSTAINED FLUTTER, EXCEPT WHERE TUNNEL BRAKES REMOVED.  
 NUMBERS ADJACENT TO CIRCLED POINTS INDICATE NAAL TEST RUN NUMBERS.  
 STIFFNESS ABOUT 74% WAS MAINTAINED AT 100% OR  $1.802 \times 10^4$  IN-LB/RAD.

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CHECKED BY J.R.S.		REPORT NO. NA-59-1736
DATE 10-24-58		MODEL NO XB-70

# VARIATION OF FLUTTER SPEED WITH ALTITUDE

FIG 16



PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC. SECRET	PAGE NO. 25 of 63
CHECKED BY: J.R.S.		REPORT NO. NA-59-1736
DATE: 11-30-59		MODEL NO. XB-70

### .10 SCALE TRANSONIC WING

This transonic flutter model test was conducted to demonstrate an adequate flutter margin at  $M = .95$ .

The cantilevered 1/10 model of the -127 configuration was constructed with 4.5 lbs/ft<sup>3</sup> styrofoam filler between isowood spars and covered with thin sheets of aluminum. The control surfaces were not free to rotate. The model was ballasted to simulate full scale empty weight distribution. A shake test of the model was conducted to determine natural frequencies and mode lines of the first three modes.

Flutter was not obtained but the model trailing edge was damaged due to flow reversal at tunnel shutdown. After repairing the model, and eliminating flow reversal by allowing the valve to remain open until all of the pressurized air was expended, very large margins were demonstrated without encountering flutter.

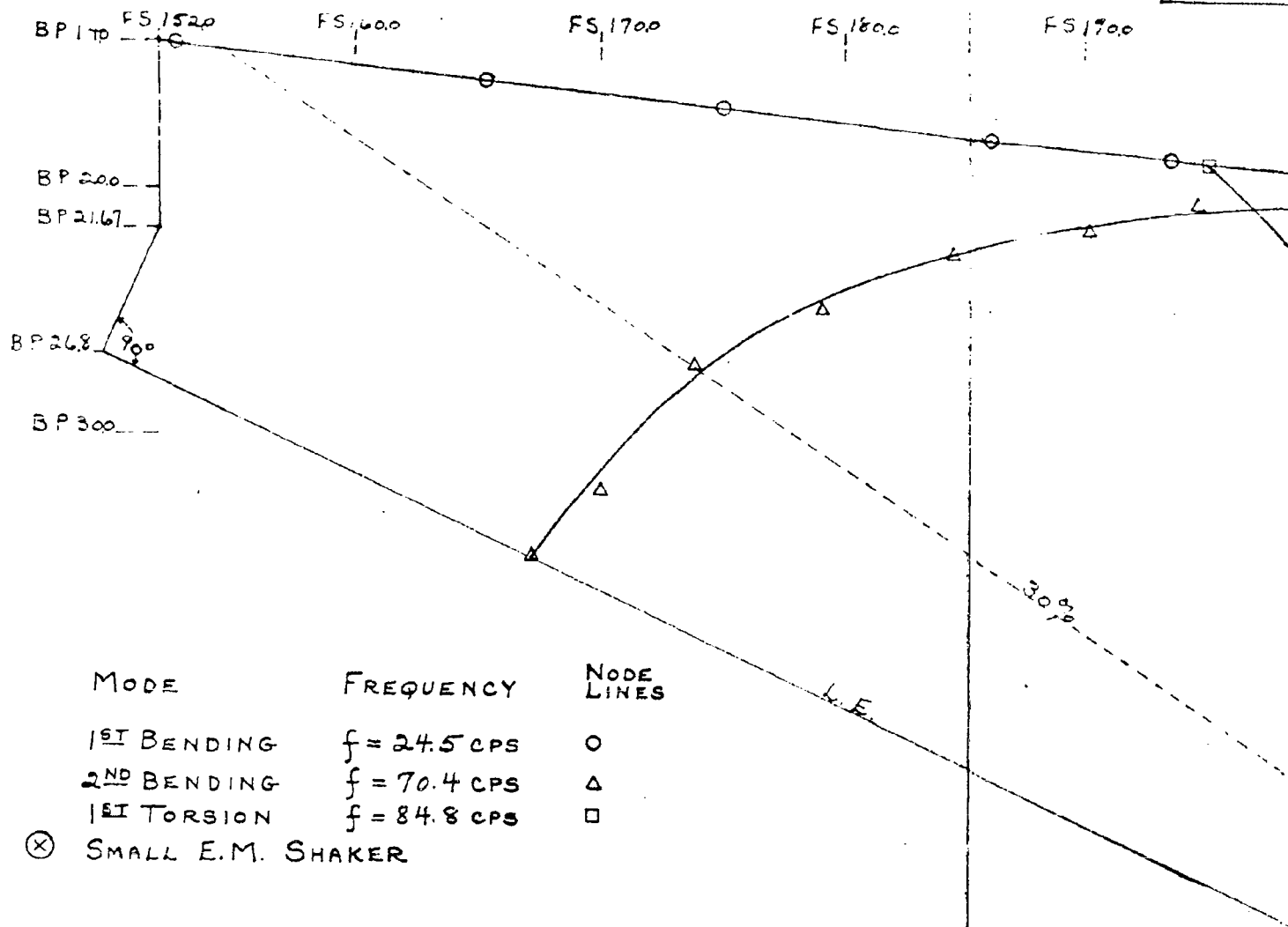
SECRET

SECRET

PREPARED BY

RECAPED BY

DATE



MODE	FREQUENCY	NODE LINES
1 <sup>ST</sup> BENDING	$f = 24.5 \text{ CPS}$	O
2 <sup>ND</sup> BENDING	$f = 70.4 \text{ CPS}$	$\Delta$
1 <sup>ST</sup> TORSION	$f = 84.8 \text{ CPS}$	$\square$
(X) SMALL E.M. SHAKER		

DESIGN FLUTTER  $q = 1800 \text{ PSF}$

MAXIMUM TEST  $q = 2050 \text{ PSF}$   
NO FLUTTER

SECRET

WING L.E. INTERSECTED A/P 2 @ FS 926

1

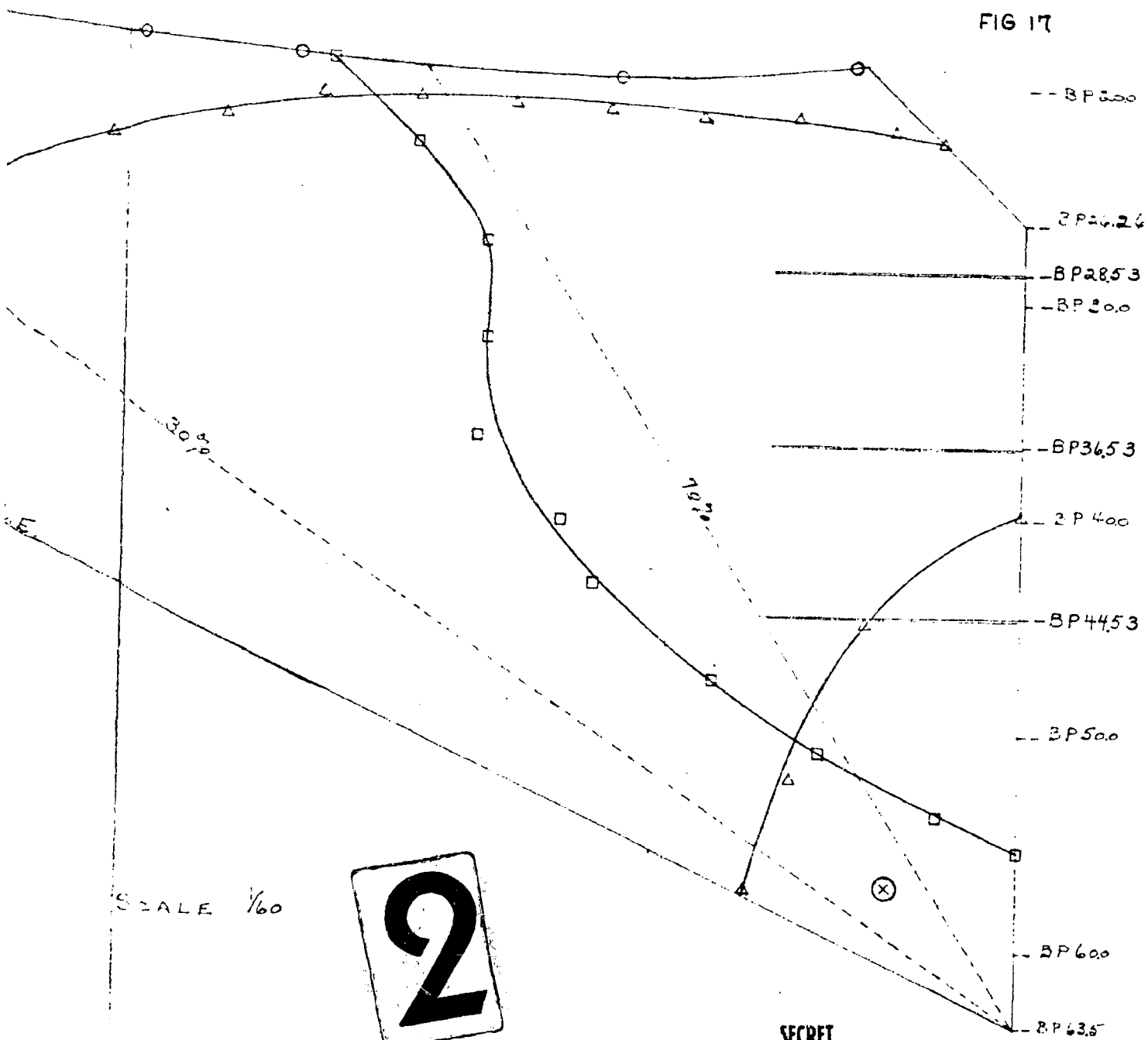
SCALE 1/60

SECRET

DESIGNED BY: <u>W.S.</u>	NORTH AMERICAN AVIATION, INC.	PAGE NO. 26 OF 63
REVIEWED BY: <u>J.R.S.</u>	SHAKE TEST RESULTS	NA-59-1736
TEST NO. <u>5-20-51</u>	10 SCALE M=9.5 MODEL SERIES	MODEL NO. <u>XB 70</u>

S1800 FS1700 FS2000 FS2200 FS2400 FS2600 FS27.6

FIG 17



SECRET

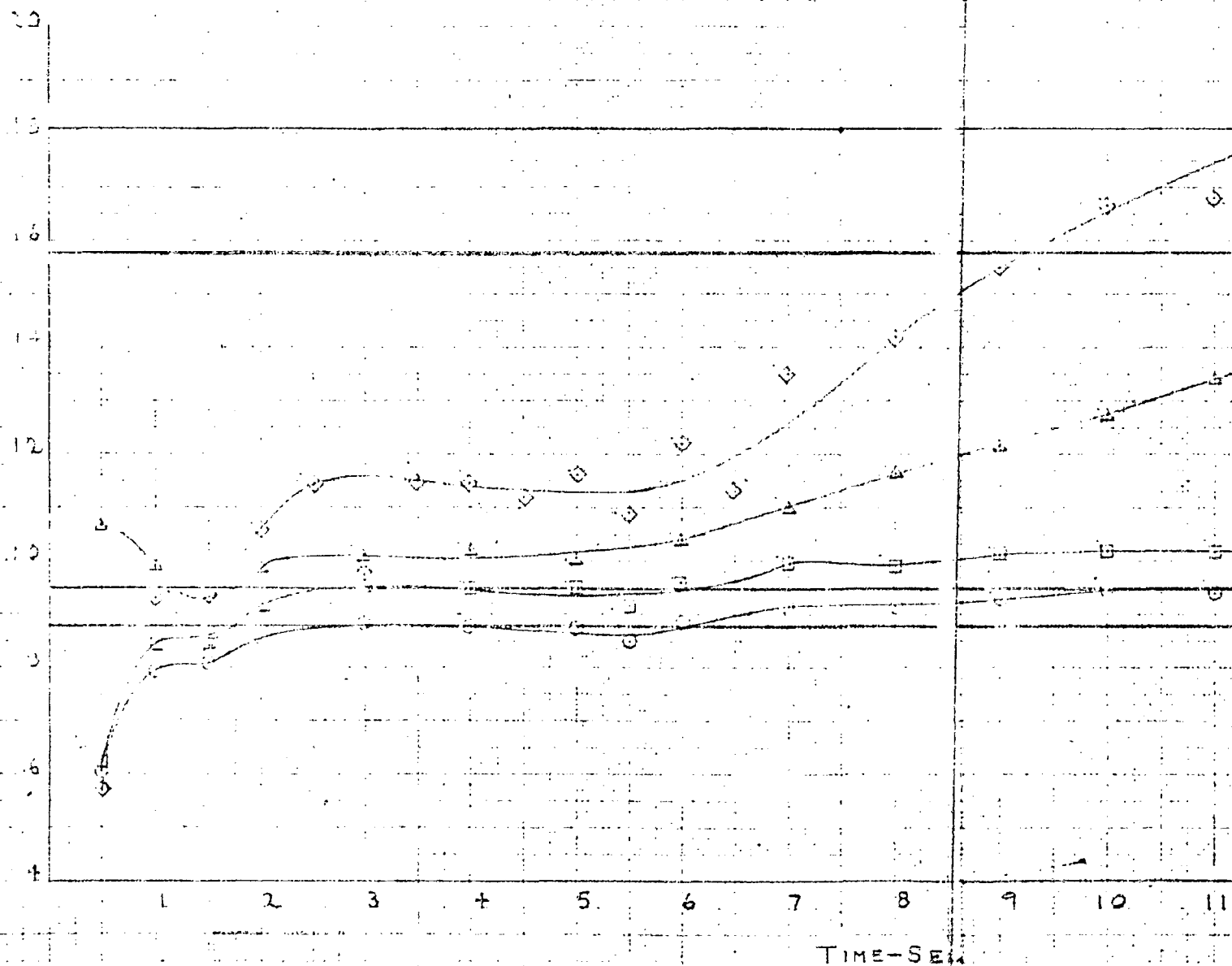
SECRET

PREPARED BY: BAK  
CHECKED BY: J.R.S.  
DATE: 7-30-58

1

# WIND TUNNEL TEST CONDITIONS FOR 95M MODEL

VARIATION OF  $\gamma$ ,  $\gamma_{pc}$ ,  $\gamma_{iso}$  AND  $M$  VS. TIME

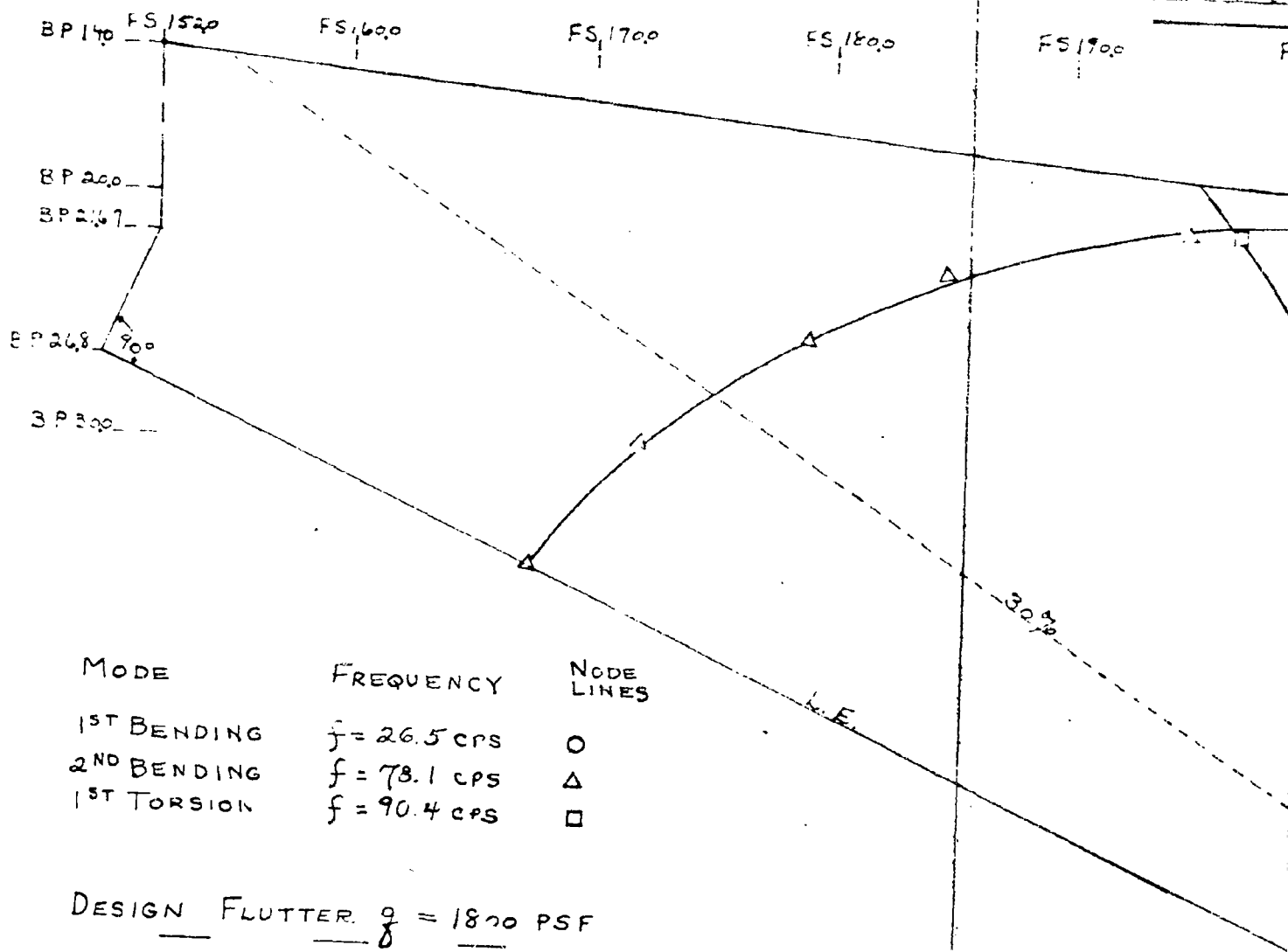


SECRET



SECRET

PREPARED BY  
 CHECKED BY  
 DATE



MODE	FREQUENCY	NODE LINES
1ST BENDING	$f = 26.5 \text{ CPS}$	O
2ND BENDING	$f = 78.1 \text{ CPS}$	$\Delta$
1ST TORSION	$f = 90.4 \text{ CPS}$	$\square$

DESIGN FLUTTER  $q = 1870 \text{ PSF}$

MAXIMUM TEST  $q = 2750 \text{ PSF}$   
 NO FLUTTER

1

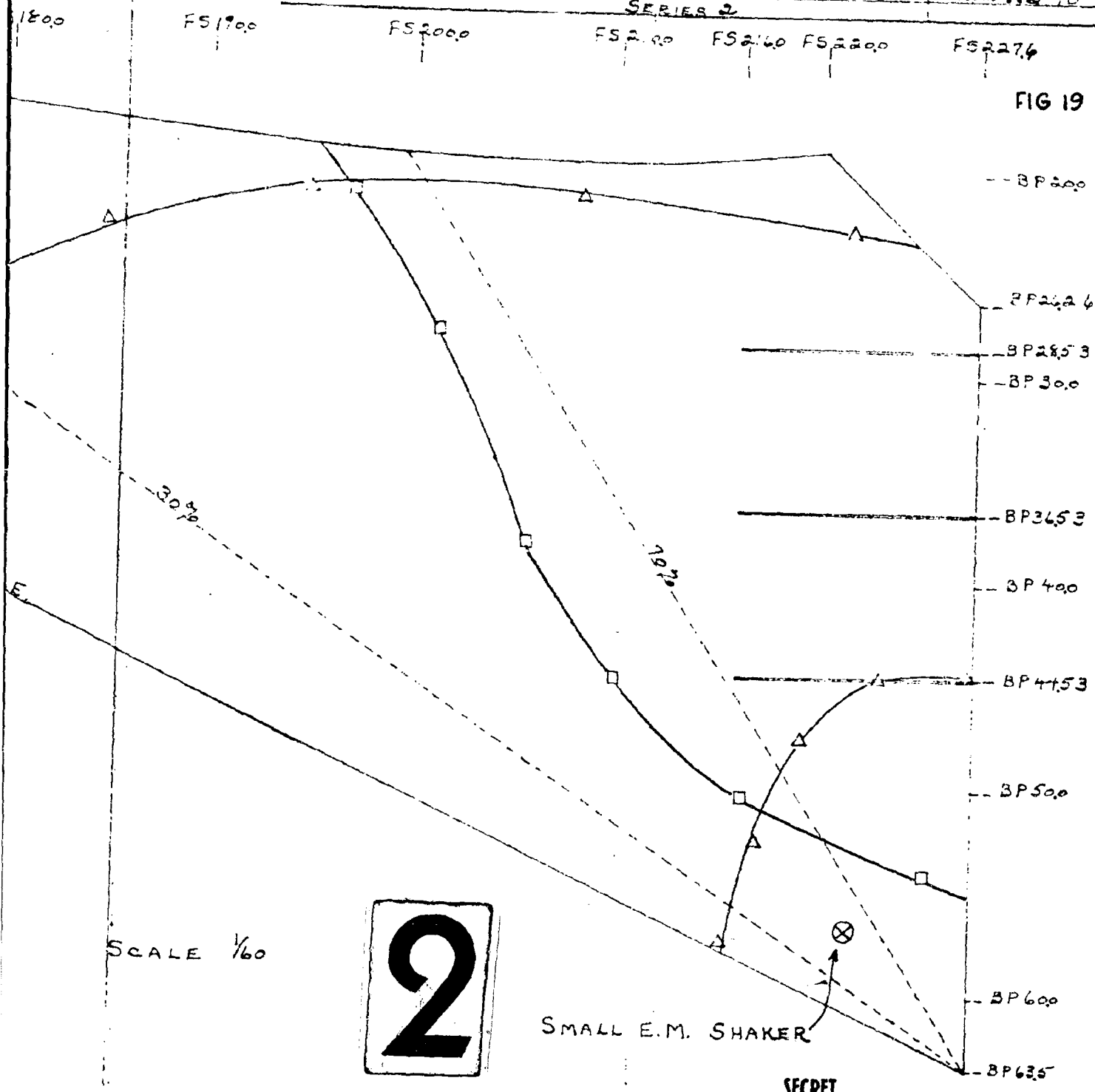
SCALE  $1/60$

WING L.E. INTERSECTS FLUTTER CURVE @ FS 926

SECRET

SECRET

PREPARED BY: V.L.S.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 28 OF 63
REVIEWED BY: J.R.S.		NA-59-1736
NO. 5-21-58	SHAKE TEST RESULTS	REPORT NO.
	REPAIRED	
	1/10 SCALE M=95 MODEL	MODEL NO. XB 70
	SERIES 2	



SECRET

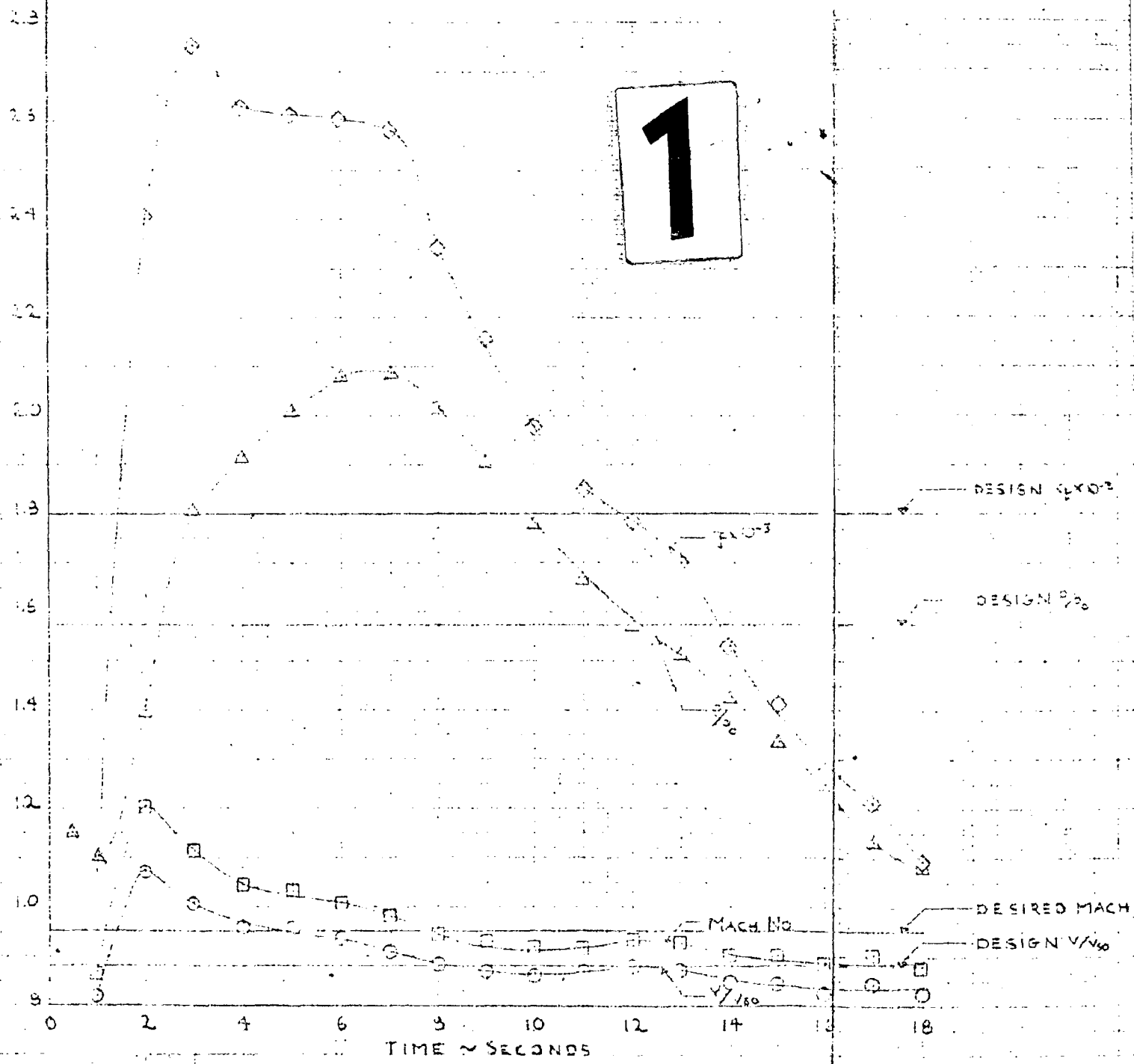
# WIND TUNNEL TEST CONDITIONS FOR 93M MODEL

SECRET

VARIATION OF  $\gamma$ ,  $\rho/\rho_0$ ,  $M$  AND  $M$  VS TIME

PREPARED BY:	BAK
CHECKED BY:	RWD
DATE:	9-18-58

1



SECRET

PREPARED BY: BAK	NORTH AMERICAN AVIATION, INC.	PAGE NO. 29 OF 63
CHECKED BY: RWD		REPORT NO. NA-59-1736
DATE: 9-18-53	SECRET	MODEL NO. XB-70

FIG 20

DESIGN  $\epsilon_{x0}^2$ DESIGN  $\rho_0$ 

2

DESIRED MACH NO.

DESIGN  $V/\sqrt{\mu_0}$ 

SECRET

PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 30 OF 63
CHECKED BY: J.R.S.	SECRET	REPORT NO. NA-59-1736
DATE: 11-30-59		MODEL NO. XB-70

### .10 SCALE SUPERSONIC WING

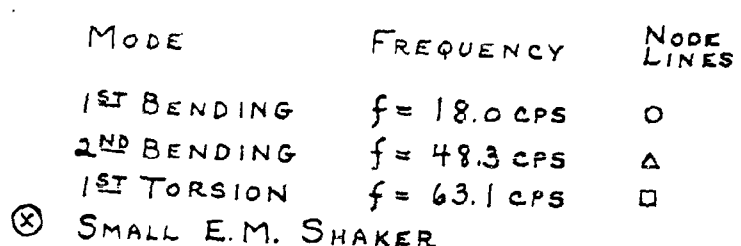
This high speed flutter model test was conducted to demonstrate an adequate flutter margin at  $M = 3.0$ .

The cantilevered 1/10 model of the -127 configuration was constructed with 3 lbs/ft<sup>3</sup> styrofoam filler between isowood spars and covered with thin aluminum sheets. The model was ballasted to simulate the full scale empty weight distribution. The control surfaces were not free to rotate. A shake test of the model was made to determine natural frequencies and node lines of the first three modes.

Flutter was not obtained but the model was destroyed as a result of tunnel starting loads.

SECRET

PREPARED BY  
REVIEW BY  
DATE



MAXIMUM TEST  $q = 2990$  PSF  
NO FLUTTER - MODEL DESTROYED BY STARTING LOADS

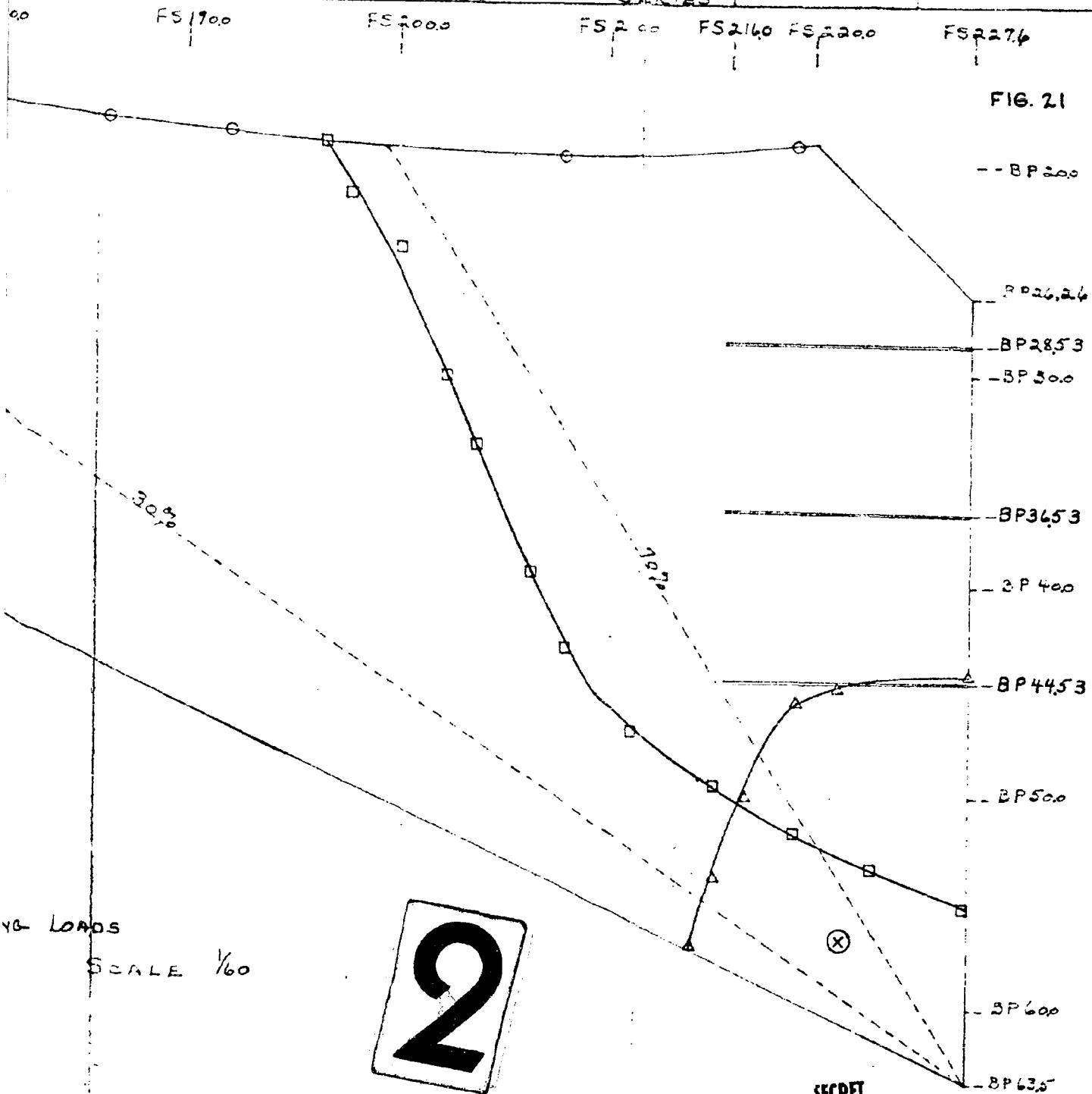
WING L.E. INTERSECTS A/p 2 & FS 926

**SECRET**

ED - 423

1

PREPARED BY: V.L.S.	NORTH AMERICAN AVIATION, INC.	PAGE NO: 31 of 63
REVIEW BY: J.R.S.		NA-54-1736
DATE: 5-21-54	SHAKE TEST RESULTS	REP BY: WC
	10 SCALE $M_1 = 3.0$ MODEL	WORK NO: XB 70
SERIES		

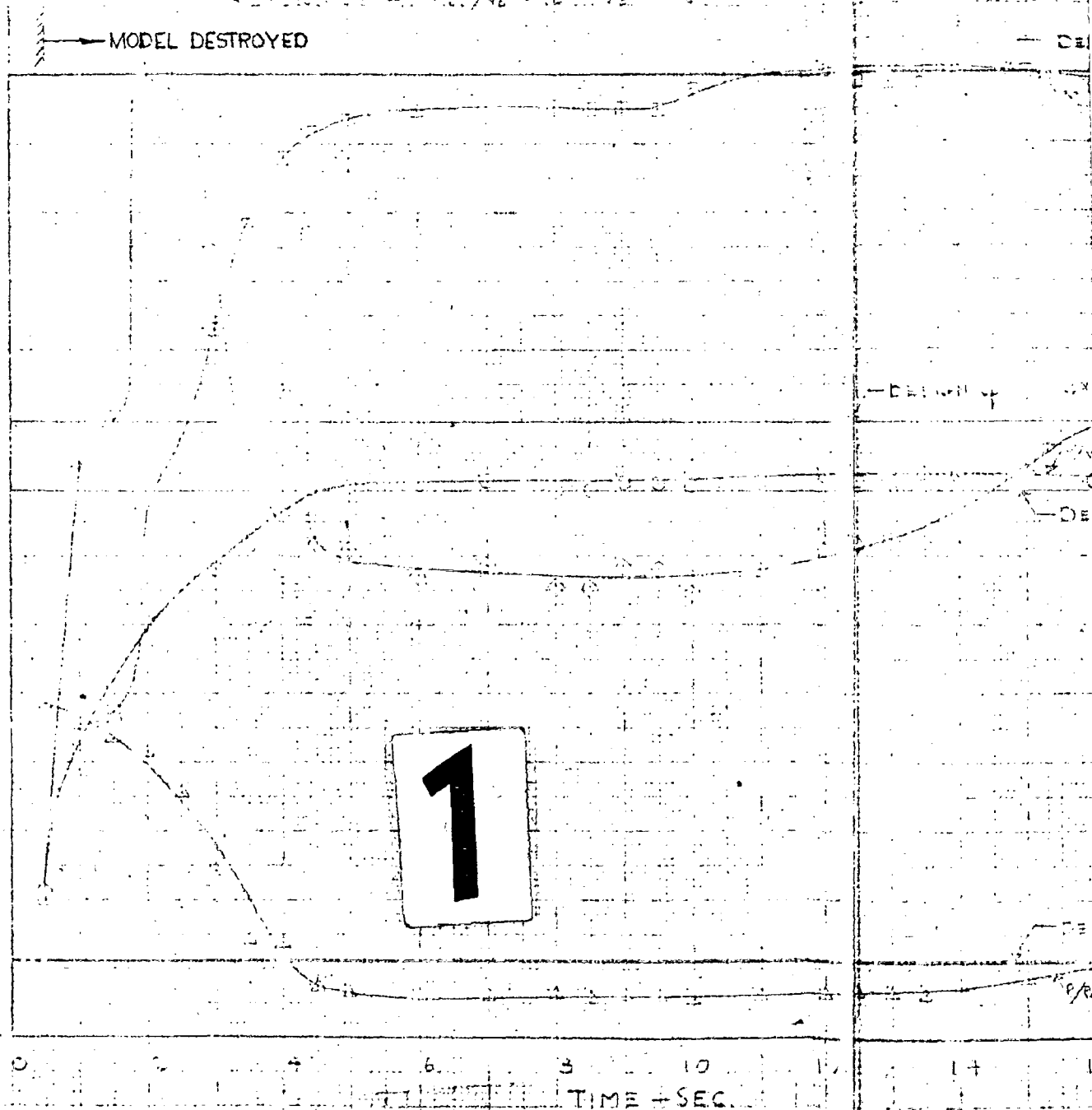


SECRET

PREPARED BY:	
CHECKED BY:	
DATE:	7-

WIND TUNNEL TEST CONDITIONS FOR B-10 MODEL

RELATION OF  $C_p$ ,  $C_m$  AND  $C_{m,0}$  VS.  $\alpha$



SECRET

PREPARED BY: BK	NORTH AMERICAN AVIATION, INC.	PAGE NO. 32 OF 63
CHECKED: VLS		REPORT NO. NA-59-1736
DATE: 7-30-58	SERIES I SECRET	MODEL NO. XB-70

FIG 22

DESIGN MACH NO.

DESIGN MACH NO.

DESIGN MACH NO.

DESIGN MACH NO.

DESIGN MACH NO.

2

SECRET

PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 33 OF 68
CHECKED BY: H.R.S.		NA-59-1736
DATE: 11-30-59	SECRET	REPORT NO.
		MODEL NO. XB-70

### .10 SCALE SUBSONIC WING

This low speed flutter model test was conducted to investigate the variation of flutter speed with the following parameters: stiffness about the 60% semi-span fold line; fuel loading; and tip deflection about the 60% semi-span fold line.

The solid styrofoam model of .1 geometric scale and .166 speed scale, was cantilever mounted in the WSC 7 3/4 x 11 foot low speed atmospheric wind tunnel at sea level density. A shake test was conducted to determine natural frequencies and mode lines of the first three modes prior to the actual flutter test.

The range of wing tip rotational stiffness levels tested had negligible effect on the flutter speed. A wing tip deflection of 50° and empty fuel loading gave the lowest flutter speed. In general flutter speed increased with increased fuel loading, increased rotational stiffness at the hinge, and decrease in tip deflection. In any configuration, the minimum flutter margin obtained was approximately 40%.

SECRET

# MODEL CHARACTERISTICS:

MATERIAL \_\_\_\_\_ SOLID STYROFOAM  
 SPEED SCALE \_\_\_\_\_ 1/6  
 ALTITUDE \_\_\_\_\_ SEA LEVEL  
 CONTROL SURFACE \_\_\_\_\_ STIFF

SECRET

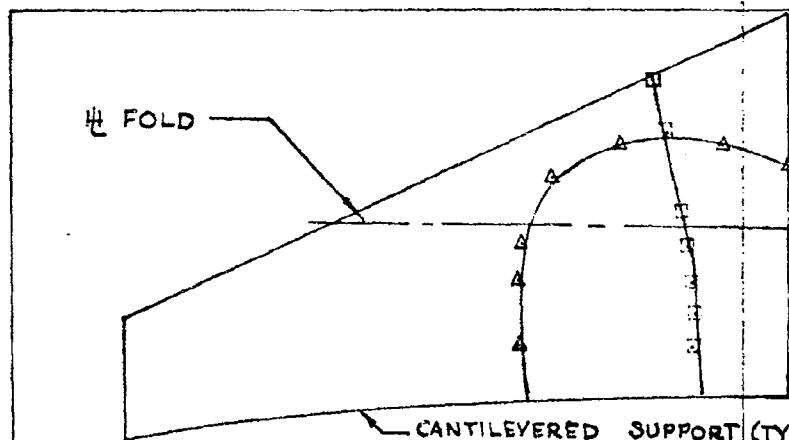
\* 100 % STIFFNESS EQUALS 74,140 IN-LB/RAD.  
 10 %

TIP DEFLECTION — DEGREES

0

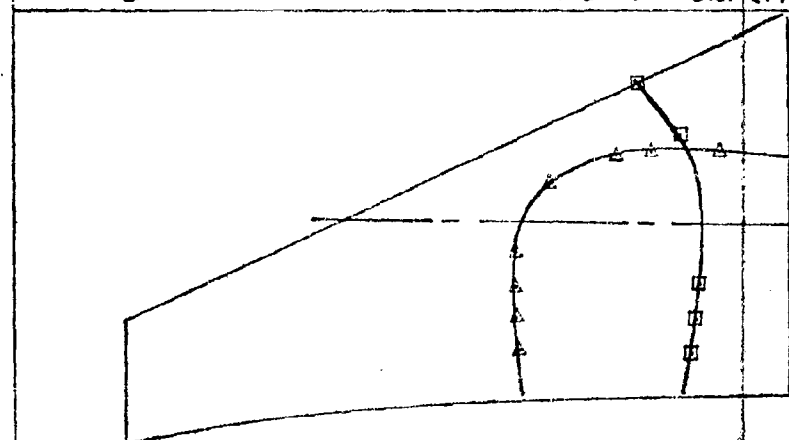
25

50



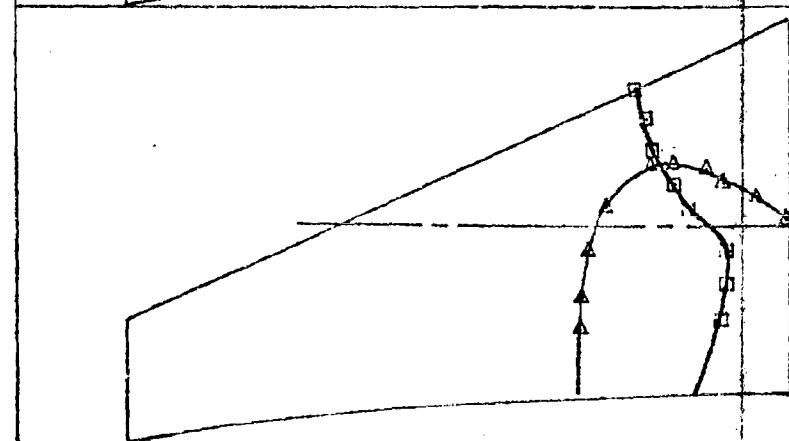
RUN #14

FLUT SPEED-MPH	172
○ 7.6 cps	1 <sup>st</sup> MODE
□ 17.0 cps	2 <sup>nd</sup> MODE
△ 24.1 cps	3 <sup>rd</sup> MODE
FLUT FREQ-cps	15.7



#17

170
○ 7.7
□ 17.0
△ 22.8
16.0



#18

169
○ 8.1
□ 17.2
△ 19.5
16.0

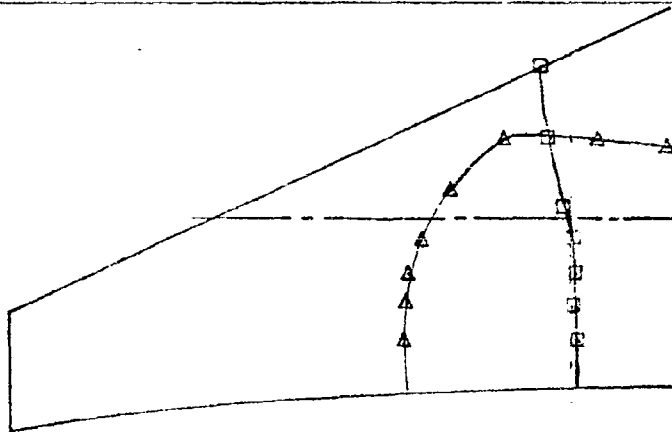
SECRET

1

# HINGE STIFFNESS

EMPTY FUEL LOADING

20%



#13

173
○ 7.6
□ 17.0
Δ 24.2
16.0

2

FFNFSS — PER CENT \*

LOADING

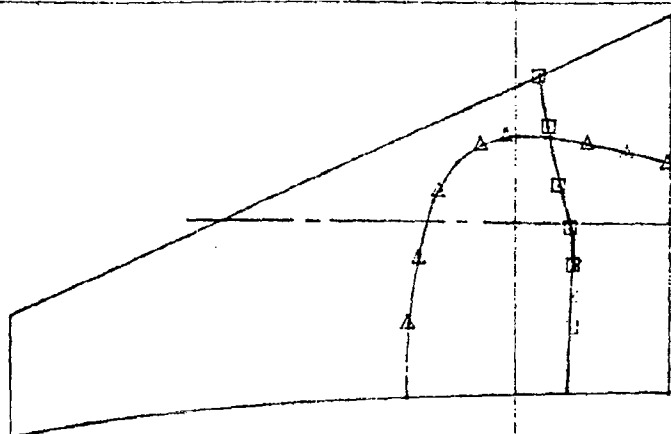
40 %

R.W.D.

AJE

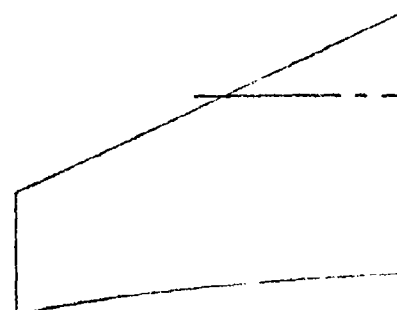
FLUTTER

1/10 SCALE



#12

	175
○	78
□	17.1
△	24.6
	15.9



3

SECRET

R.W.D.

AJE

34 63  
NA-59-1736

24C

# FLUTTER AND SHAKE TEST RESULTS

XB-70

1/10 SCALE WING MODEL

NAAL TEST # 439

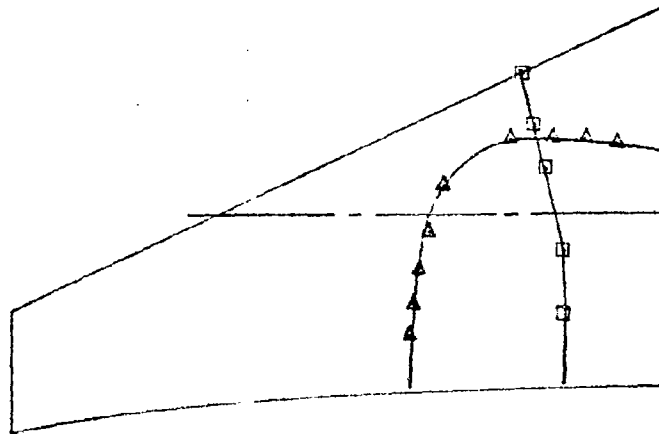
FIG 23

80 %

#12

#11

175
7.8
17.1
24.6
15.9



175
7.7
17.1
23.7
16.0

4

SECRET

MODEL CHARACTERISTICS:

SECRET

MATERIAL \_\_\_\_\_ SOLID STYROFOAM  
 SPEED SCALE \_\_\_\_\_ 1/6  
 ALTITUDE \_\_\_\_\_ SEA LEVEL  
 CONTROL SURFACE \_\_\_\_\_ STIFF  
 HINGE LINE STIFFNESS AT FOLD \_\_\_\_\_ 7,414 IN-LB/RAD (10%)

EMPTY

TIP DEFLECTION—DEGREES

0

25

50

# FOLD

CANTILEVERED SUPPORT (TYPICAL)

RUN #14

FLUT SPEED-MPH 172	
○	7.6 CPS 1 <sup>ST</sup> MODE
□	17.0 CPS 2 <sup>ND</sup> MODE
△	24.1 CPS 3 <sup>RD</sup> MODE
FLUT FREQ-CPS 15.7	

# 17

170	
○	7.7
□	17.0
△	22.8
16.0	

#18

169	
○	8.1
□	17.2
△	19.5
16.0	

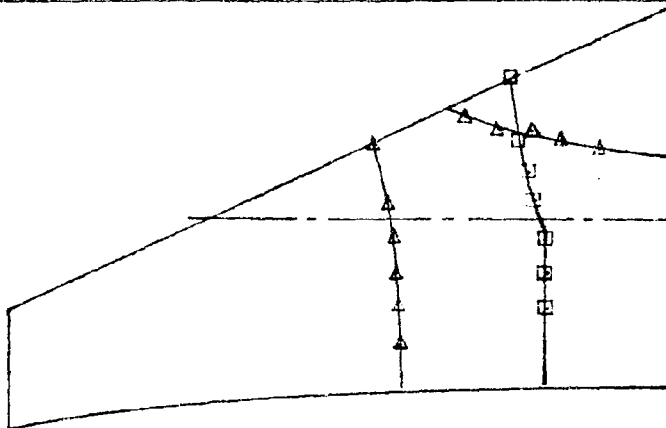
SECRET

1

# FUEL LOADING

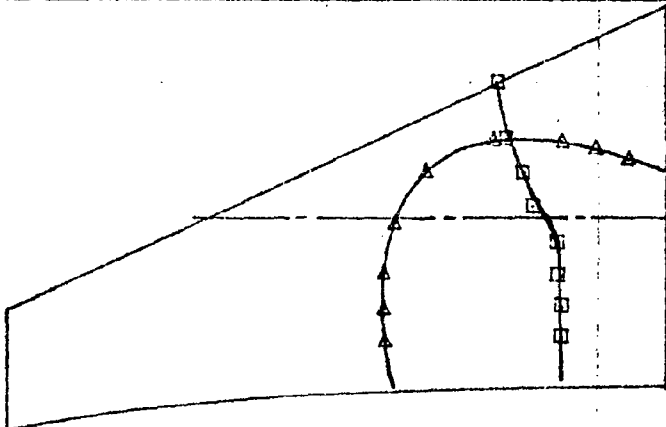
1/4 LEVEL

#32



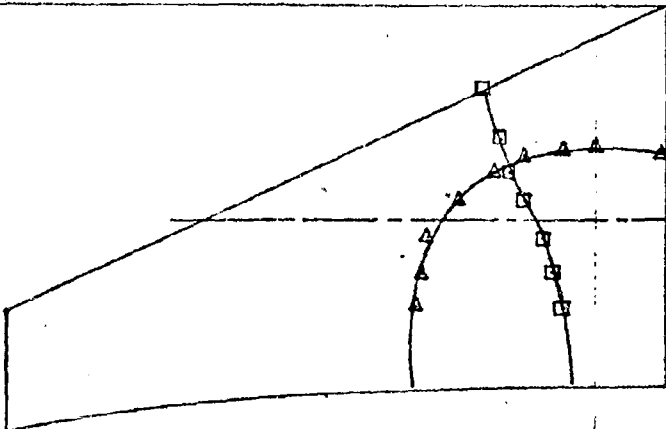
	190
○	7.1
□	14.5
△	22.1
	13.6

#31



	193
○	7.1
□	14.6
△	21.0
	13.5

#24



	191
○	7.6
□	14.9
△	18.4
	13.7

2

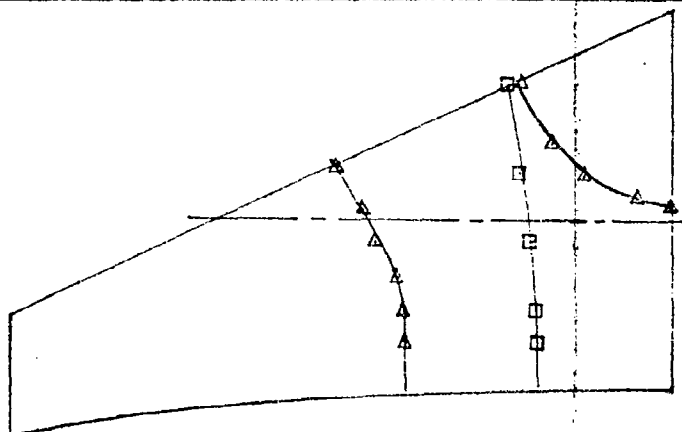
# ADING

# 3

R.W.D.  
AJE

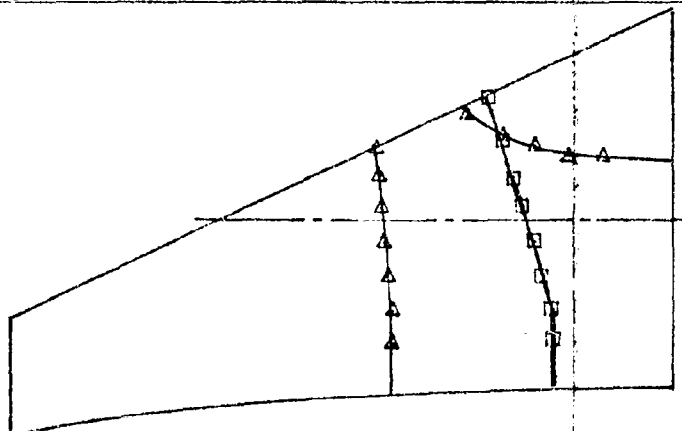
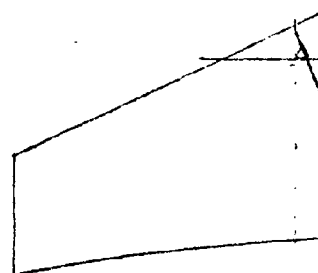
FLU  
1/10

1/2 LEVEL



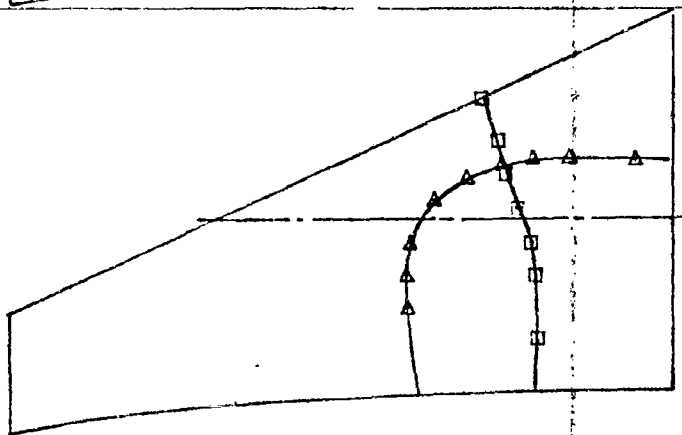
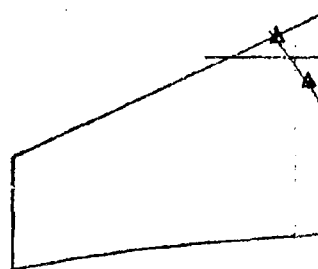
#16

	195
○	6.7
□	13.2
△	20.0
	11.5



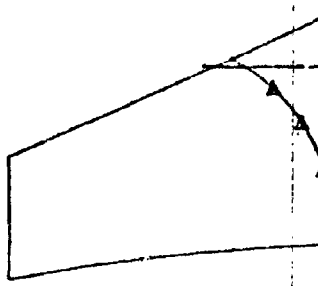
#30

	203
○	6.7
□	13.1
△	19.6
	12.0



#20

	203
○	7.1
□	13.3
△	18.2
	12.0



SECRET

R.W.D.

AJE

NAVATION

35 63

NA-59-1736

# FLUTTER AND SHAKE TEST RESULTS

1/10 SCALE

WING

MODEL

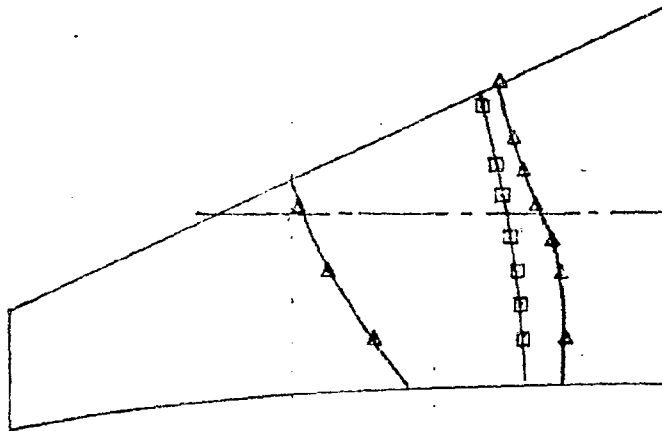
XB-70

NAAL TEST #439

FIG 24

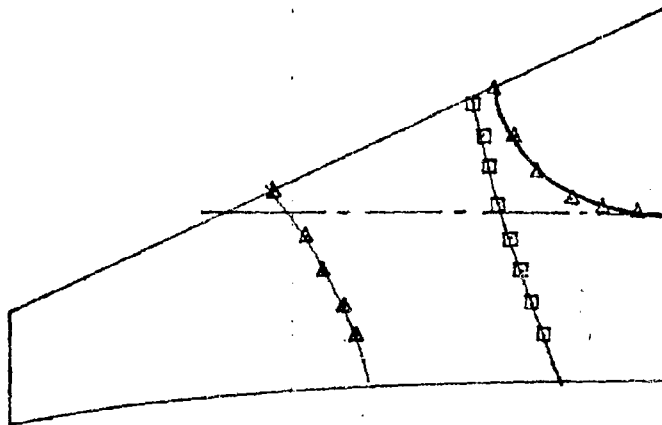
FULL

#15



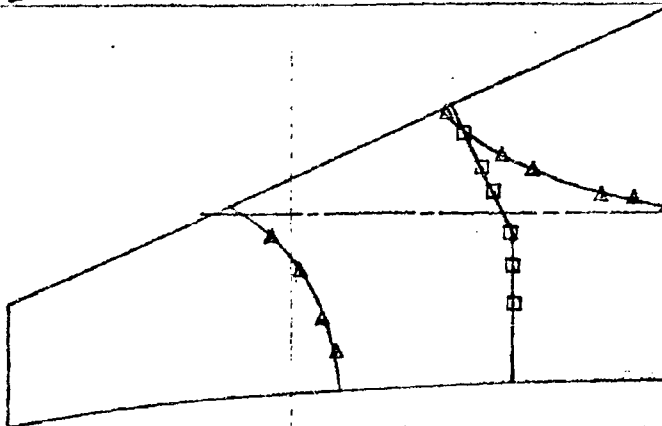
202 <sup>+</sup>
○ 5.9
□ 11.3
Δ 14.9
~10.1

#28



203 <sup>+</sup>
○ 6.0
□ 11.2
Δ 15.7
~10.4

#19



203 <sup>+</sup>
○ 6.3
□ 11.6
Δ 15.7
~10.3

4

SECRET

# MODEL CHARACTERISTICS:

SECRET

MATERIAL \_\_\_\_\_ SOLID STYROFOAM  
 SPEED SCALE \_\_\_\_\_ 1/6  
 ALTITUDE \_\_\_\_\_ SEA LEVEL  
 CONTROL SURFACE \_\_\_\_\_ STIFF  
 HINGE LINE STIFF AT FOLD \_\_\_\_\_ 7,414 IN-LB/RAD (10%)

## FULL FORWARD

TIP DEFLECTION — DEGREES

0

25

50

FOLD

FWD AFT

CANTILEVERED SUPPORT (TYPICAL)

RUN#

FLUT SPEED-MPH	
○	CPS-1 MODE
□	CPS-2 MODE
△	CPS-3 MODE
FLUT FREQ-CPS	

#27

203+	
○	7.1
□	11.5
△	15.9
~ 10.7	

#26

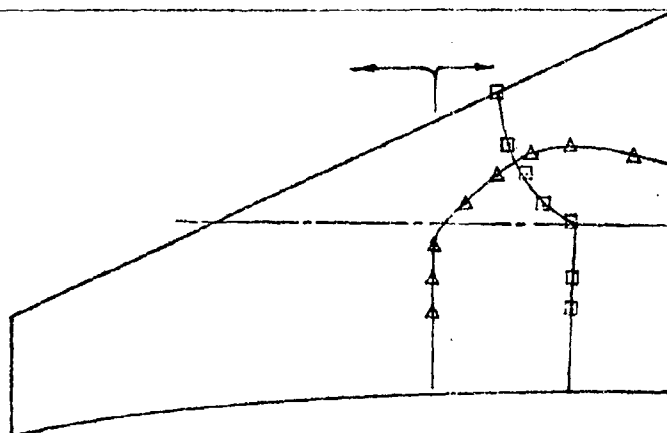
203+	
○	7.5
□	11.5
△	16.2
~ 11.3	

SECRET

# 2

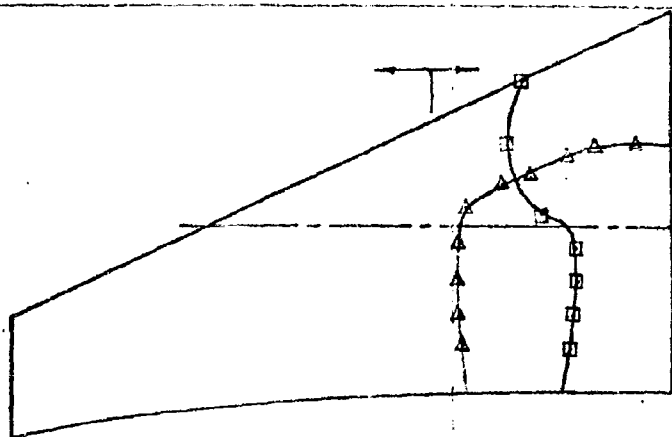
FULL AFT

TIP E



#29

203
○ 6.2
□ 15.3
△ 20.5
14.1



#25

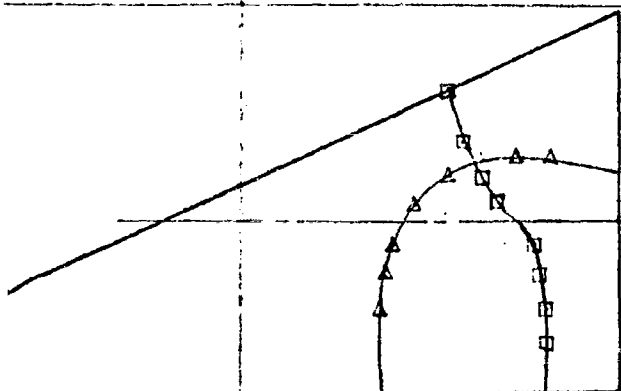
203+
○ 6.8
□ 15.3
△ 18.2
~13.3

# FUEL LOADING

TIP EMPTY INBOARD 1/4 LEVEL

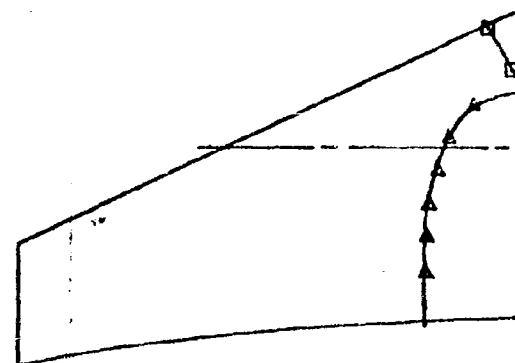
TIP EMPTY INBO

3



#23

	177
○	8.0
□	15.5
△	18.7
	14.5



R.W.D.

AJE

FLUTTER AND SHAKE T  
1/10 SCALE WING  
NAAL TEST #438

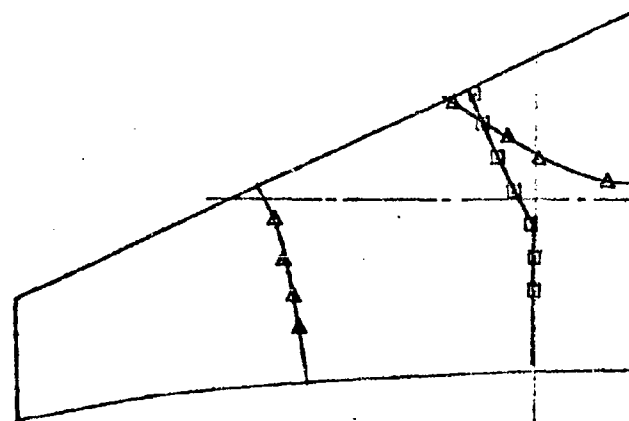
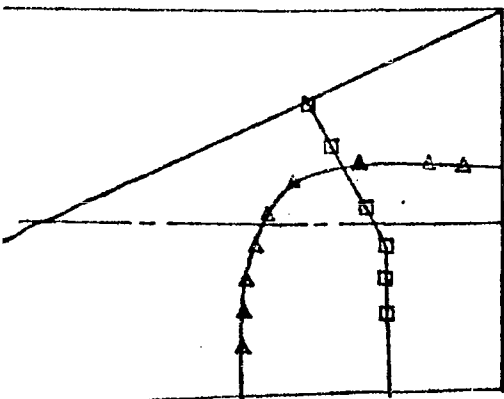
P EMPTY INBOARD 1/2 LEVEL

TIP EMPTY INBOARD

3

#22

	181
○	7.8
□	14.1
△	18.0
	13.1



R.W.D.

AJE

# FLUTTER AND SHAKE TEST RESULTS

1/10 SCALE WING  
NAA L TEST # 439

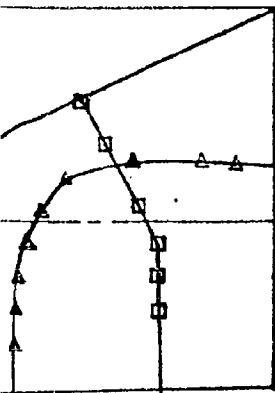
MODEL

INBOARD 1/2 LEVEL

TIP EMPTY INBOARD FULL

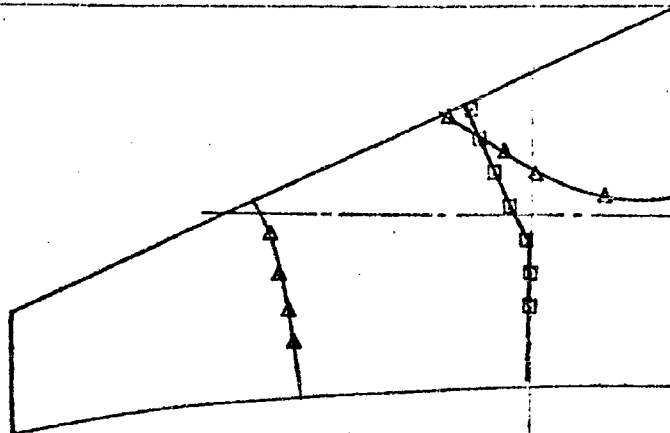
4

#22



	181
○	7.8
□	14.1
△	18.0
	13.1

# 21



	200+
○	7.7
□	12.2
△	16.3
	~11.4

SECRET

SECRET

R.W.D.

AJE

36

63

NA-59-1736-44C

X6-70

# FLUTTER AND SHAKE TEST RESULTS

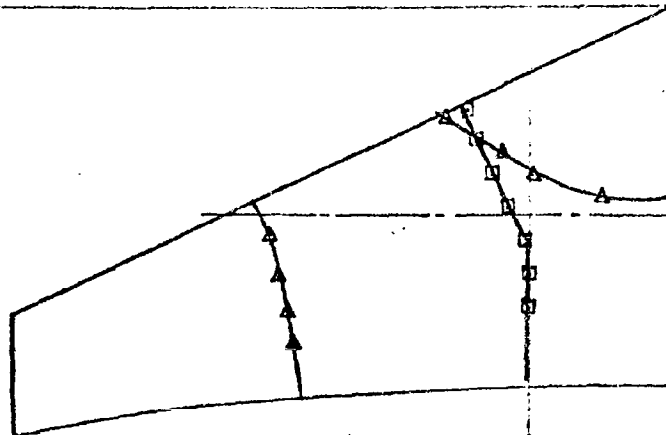
1/10 SCALE WING MODEL  
NAAL TEST #439

FIG 25

TIP EMPTY INBOARD FULL

5

# 21



	200+
○	7.7
□	12.2
△	16.3
	~11.4

SECRET

11
8
.1
0
.1

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CHK BY: AJE

SECRET

NA-59-1736

DATE:

# FLUTTER AND SHAKE TEST RESULTS

MODEL NO. XB-70-440

DIS. SCALE WING MODEL

FIG 26

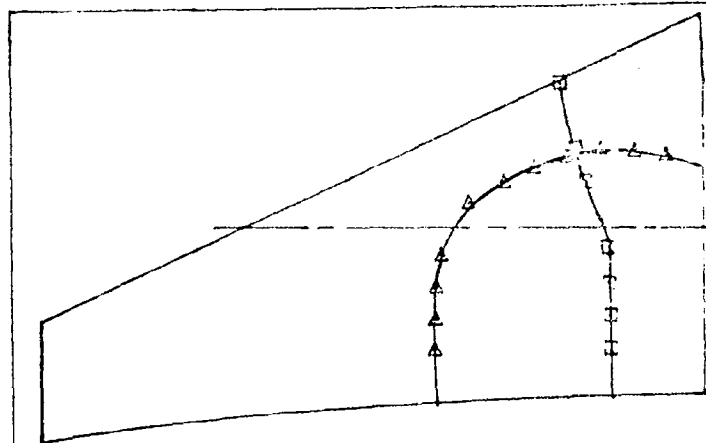
## 5° LEADING EDGE DROOP FUEL LOADING EMPTY

TIP DEFLECTION - DEGREES

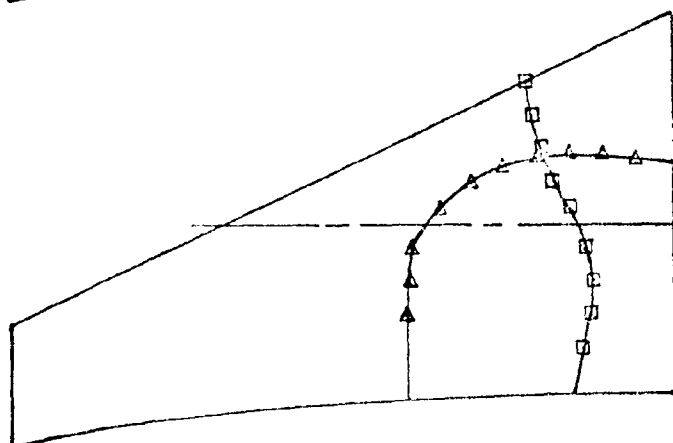
0

25

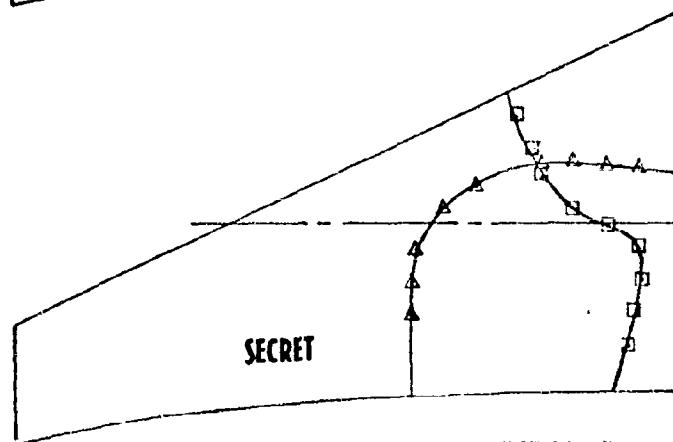
50



FLUT SPEED - mph	174
○ 7.5 cps 1 <sup>ST</sup> MODE	
□ 17.2 cps 2 <sup>ND</sup> MODE	
△ 23.7 cps 3 <sup>RD</sup> MODE	
FLUT FREQ - cps	15.7



FLUT SPEED - mph	173
○ 7.7	
□ 17.5	
△ 22.7	
FLUT FREQ - cps	16.1



FLUT SPEED - mph	172
○ 8.3	
□ 17.7	
△ 20.2	
FLUT FREQ - cps	16.3

SECRET

DESIGNED BY P.H.K. NORTH AMERICAN AVIATION, INC. PAGE NO. 38 OF 63  
 CHECKED BY J.R.S. LOW SPEED FLUTTER MODEL TEST REPORT NO. NA-59-1736  
 DATE \_\_\_\_\_ RESULTS SECRET -440 CANT. WING MODEL NO. XB-70-440

B-70 WING NAAL TEST #439

FIG 27

DEC. 9, 1958 TO DEC. 17, 1958

MODEL CHARACTERISTICS:

GEOMETRIC SCALE \_\_\_\_\_ .1  
 SPEED SCALE \_\_\_\_\_ .166  
 MATERIAL SOLID STYROFOAM

ALTITUDE \_\_\_\_\_ S.L.  
 CONTROL SURFACE STIFF  
 SUPPORT CANT. FROM FLOOR

TABULAR SUMMARY FLUTTER TEST RESULTS

MODEL FLUTTER SPEED ~ M.P.H.

HINGE STIFF- NESS	LEVEL FUEL LOADING					VARIED FUEL LOADING		TIP REFLECTOR	OSCIL RECORD NO.	SHAKE TEST RESULTS				FLUT. FREQ.
	FULL	3/4	1/2	1/4	EMPTY	# FWD	# AFT	0° 25° 50°		W <sub>1</sub> CPS	W <sub>2</sub> CPS	W <sub>3</sub> CPS	W <sub>4</sub> CPS	
80					175			✓	11	1913	7.7	17.1	23.7	16.0
40					175			✓	12	1921	7.8	17.1	24.6	15.9
20					173			✓	13	1922	7.6	17.0	24.2	16.0
10					172			✓	14	1924	7.6	17.0	24.1	15.7
10	>202							✓	15	1926	5.9	11.3	14.9	~10.1
10			195					✓	16	1927	6.7	13.2	20.0	11.5
10					170			✓	17	1928	7.7	17.0	22.8	16.0
10					169			✓	18	1929	8.1	17.2	19.5	16.0
10	>203							✓	19	1931	6.3	11.6	15.7	~10.3
10			203					✓	20	1932	7.1	13.3	18.2	12.0
10	ING'D >200				TIP >200			✓	21	1933	7.7	12.2	16.3	~11.4
10			ING'D 181		TIP 181			✓	22	1934	7.8	14.1	18.0	13.1
10				ING'D 177	TIP 177			✓	23	1936	8.0	15.5	18.7	14.5
10				191				✓	24	1937	7.6	14.9	18.4	13.7
10							>203	✓	25	1938	6.8	15.3	18.2	~13.3
10							>203	✓	26	1939	7.5	11.5	16.2	~11.3
10							>203	✓	27	1941	7.1	11.5	15.9	~10.7
10	>203							✓	28	1942	6.0	11.2	15.7	~10.4
10							203	✓	29	1943	6.2	15.3	20.5	14.1
10			203					✓	30	1944	6.7	13.1	19.6	12.0
10				193				✓	31	1945	7.1	14.6	21.0	13.5
10				190				✓	32	1949	7.1	14.5	22.1	13.6
5° LEADING EDGE DROOP														
10					174			✓	33	2021	7.5	17.2	23.7	15.7
10					173			✓	34	2022	7.7	17.5	22.7	16.1
10					172			✓	35	2023	8.3	17.7	20.2	16.3

# WTS #5, 6, 12, 13, 19, 20 & 25

# WTS #1, 2, 3, 4, 9, 10, 11, 17, 18 & 24

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DATE: 11-30-59	SECRET	REPORT NO.
		MODEL NO. XB-70

### .15 SCALE SUBSONIC VERTICAL TAIL

Various root support stiffness magnitudes and distributions were investigated using a .15 scale model of the canted hinge configuration of the vertical tail.

The model was constructed of 4.5lbs/ft<sup>3</sup> density solid styro-foam whose thickness at any point in the planform simulated full scale bending stiffness. The mass distribution of the model simulated full scale total mass at sea level conditions. In some sections near the root, the model was slightly overweight but the effects on flutter speed should be very small. The model was built to a .15 geometric scale and a .2 speed scale.

Lateral stiffness of the upper and lower hinges and the actuator point were simulated by small cantilevered beams. These springs were calibrated dynamically by attaching a known mass on the spring and recording the free vibration on an oscillograph to allow accurate determination of the spring constants. Root spring constants simulated were as follows:

LOCATION	MODEL SCALE - LBS/IN			FULL SCALE ~ LBS/IN		
Upper Hinge	498.5	236.8	85.5	84,083	38,467	14,250
Lower Hinge	986	637.9		164,333	106,317	
Actuator	63.1	19.9		10,517	3,317	

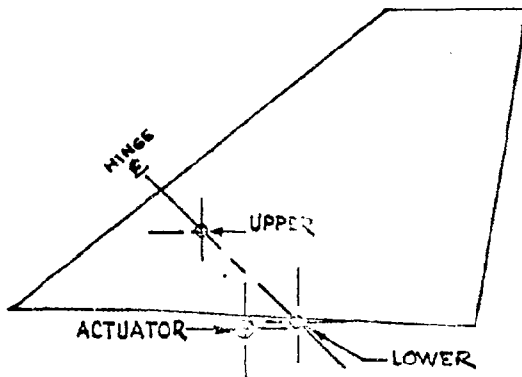
Prior to the actual flutter test of each configuration, a shake test was conducted to determine natural frequencies and node lines of the first three modes. The flutter tests were conducted in the WSC 7 3/4 x 11 foot, low speed, atmospheric wind tunnel at sea level density.

The flutter tests showed that actuator stiffness is relatively unimportant. Decreasing the actuator stiffness improved bending-torsion frequency ratios slightly resulting in a small increase in flutter speed. It further showed that the largest increments in flutter speed were obtained by increasing the stiffness of the upper hinge point. In all configurations tested but one, the flutter frequency fell between the zero air speed frequencies for second bending and first torsion.

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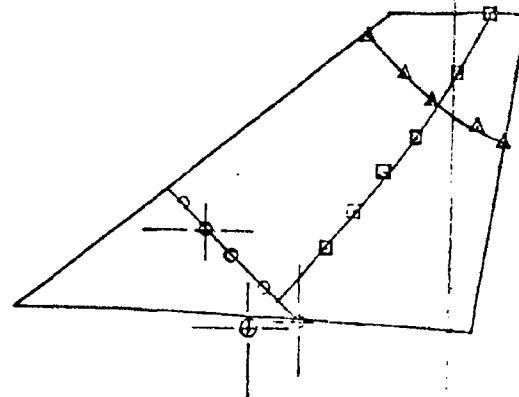
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CHECKED BY: J.  
DATE: 12-



UPPER	LOWER	ACTUATOR
STIFFNESS		
FLUTTER SPEED-MPH		
○ 1 <sup>ST</sup> BENDING ~CPS		
△ 2 <sup>ND</sup> BENDING ~CPS		
□ 1 <sup>ST</sup> TORSION ~CPS		
FLUTTER FREQ- CPS		

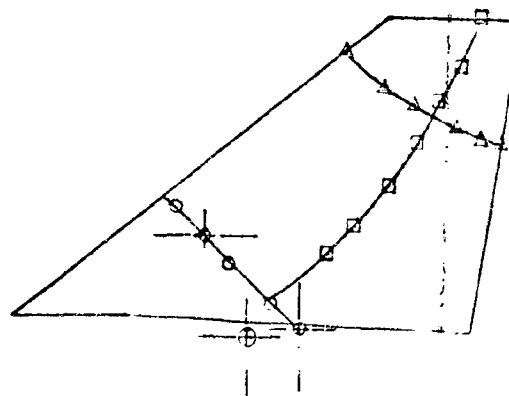
SPRING CONSTANT ~ K- LB/IN		
UPPER	LOWER	ACTUATOR
236.8	986	63.1
85.5	637.9	19.9



U	L	A
STIFF	STIFF	STIFF
165.5		
3.6		
24.3		
34.0		
25.0		

MODEL CHARACTERISTICS:

GEOMETRIC SCALE \_\_\_\_\_ .15  
MATERIAL \_\_\_\_\_ SOLID STYROFOAM  
SPEED SCALE \_\_\_\_\_ .20  
ALTITUDE \_\_\_\_\_ SEA LEVEL  
HINGE STIFFNESS \_\_\_\_\_ VARIES  
SUPPORT \_\_\_\_\_ HINGES



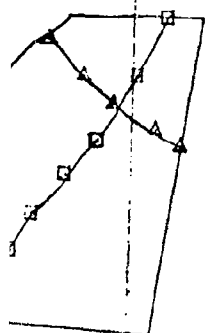
U	L	A
STIFF	FLEX	FLEX
166.5		
2.0		
23.7		
33.1		
25.0		

1

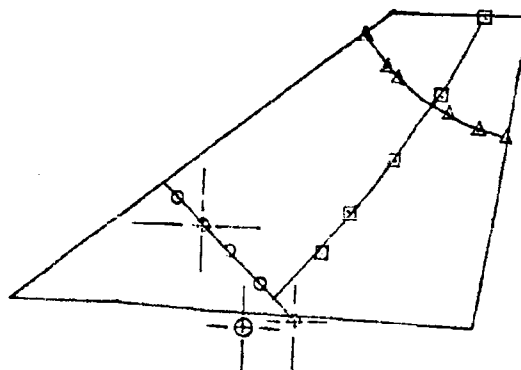
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PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC. FLUTTER & SECRET	PAGE NO. 40 OF 63
CHECKED BY: J.R.S.		REPORT NO. NA-59-1736
DATE: 12-8-58	SHAKE TEST RESULTS ~.15 SCALE CANTED HINGE VERTICAL TAIL - 44C CONFIG NAAL#433	MODEL NO. XB-70

FIG 2.8

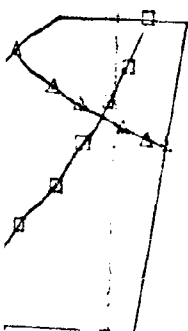


U	L	A
STIFF	STIFF	STIFF
165.5		
3.6		
24.3		
34.0		
25.0		

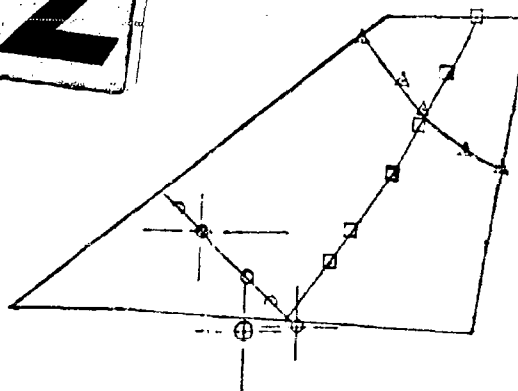


U	L	A
STIFF	FLEX	STIFF
165		
3.6		
24.2		
33.2		
24.5		

2



U	L	A
STIFF	FLEX	FLEX
166.5		
2.0		
23.7		
33.1		
25.0		



U	L	A
FLEX	FLEX	FLEX
133		
2.0		
23.7		
26.1		
21.9		

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NA-59-1736

REPORT NO.

DATE:

FLUTTER AND SHAKE TEST RESULTS OF THE  
 .15 SCALE CANTED HINGE VERTICAL TAIL -44C  
 NAS-44C

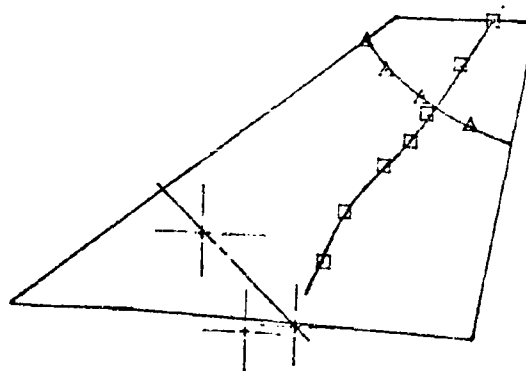
MODEL NO. XB-70

FIG 29

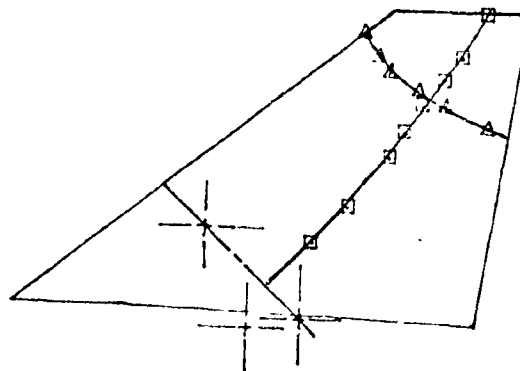
MODEL CHARACTERISTICS:

GEOMETRIC SCALE .15  
 MATERIAL SOLID STYROFOAM  
 SPEED SCALE .20  
 ALTITUDE SEA LEVEL  
 HINGE STIFFNESS VARIES  
 SUPPORT HINGES

SPRING CONSTANT ~ K- LB/IN		
UPPER	LOWER	ACTUATOR
236.8	986	63.1
85.5	637.9	19.9
498.5		



U	L	A
EXTRA STIFF	STIFF	STIFF
179		
3.7		
24.7		
36.1		
—		



U	L	A
EXTRA STIFF	FLEX	STIFF
178		
3.7		
24.7		
35.7		
25.3		

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DATE: 11-30-59		MODEL NO. XB-70

.06 SCALE STIFF WING WITH FLEXIBLE ELEVONS  
AND .20 SCALE STIFF CANARD WITH FLEXIBLE FLAPS

The purpose of these models was to check required elevon and flap rotational frequencies to prevent single-degree control surface rotational flutter at low supersonic speeds. The tests were conducted in TWT on 2 February 1959 through 4 February 1959 for 48.2 test hours for the elevons and on 4 February 1959 through 8 February 1959 for 34.0 test hours for the flaps.

On the basis of two-dimensional supersonic linearized oscillatory aerodynamic theory it can be shown that single-degree supersonic control surface rotation flutter is independent of the percent chord location of the hinge line. This leads to a theoretical flutter boundary in a plot of  $\frac{V}{c\omega}$  versus Mach number which is applicable to

all hinged control surfaces in two-dimensional linearized flow. Figure 30 shows this boundary and some experimental flutter points obtained in flight tests. Since the theory indicates that instability occurs when the flutter frequency is below a certain critical value (depending somewhat on the Mach number) it can be seen that this type of flutter becomes more critical as the altitude is increased as a result of decreased flutter frequencies due to decreased aerodynamic stiffness.

Test conditions were selected in accordance with the theoretical predictions in that the control surface mass ratio was chosen so that the tunnel density range corresponded to an area in the flight envelope extending downward from the upper boundary over the range of Mach numbers from 1.0 to 1.5 and hinge flexures were tuned to provide several rotational frequencies ranging downward from the theoretical requirement. Conditions covered are shown in Figures 31 and 32.

Flutter was not obtained for any stiffness value tested even though the most flexible configuration should have had a flutter frequency approximately equal to 40% of the

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DATE: <b>11-30-59</b>		MODEL NO. <b>XB-70</b>

theoretically required value for neutral stability on the basis of a detailed flutter analysis for the elevons, and an even lower percentage for the flaps. These results are not considered conclusive in view of the instabilities obtained in actual flight tests of earlier airplanes. This discrepancy between model and full scale test results may be due to relatively low model Reynolds numbers, shocks reflected from the porous walls of the test section or even to the possibility that the full scale phenomenon may have been transonic buzz dependent on shock and boundary layer conditions. Regardless of the explanation, B-70 elevons and flaps will continue to be designed to the theoretically required stiffness since no weight penalty is involved for reasonable configurations and a fairly high level of stiffness is required to prevent coupled flutter involving the control surfaces.

**SECRET**

HKA

J.R.S.

**SECRET**

44 63  
NA-59-1736

MODEL NO. XB-70

DATE 11-30-59

COMPARISON OF THEORETICAL AND EXPERIMENTAL REDUCED VELOCITIES FOR SINGLE DEGREE FLUTTER OF CONTROL SURFACES AT SUPERSONIC MACH NUMBERS.

C	CONTROL SURFACE CHORD
V	TRUE VELOCITY
Q	FLOUTTER FREQUENCY

EXPERIMENTAL  
THEORETICAL

0	7	FJ-2	RUBBER
0	0	FJ-2	ELEVATOR
0	0	KFJ-2	AILERON
0	0	VF-100	A RUDDER

FLIGHT

# WILFRED

THE UNIVERSITY OF CHICAGO

20

**SECRET**

**RELAXED  
VELOCITY:**

43

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DATE

J.R.S.

06 SCALE

SECRET

STIFF WING WITH

REPORT NO. NA-59-1736

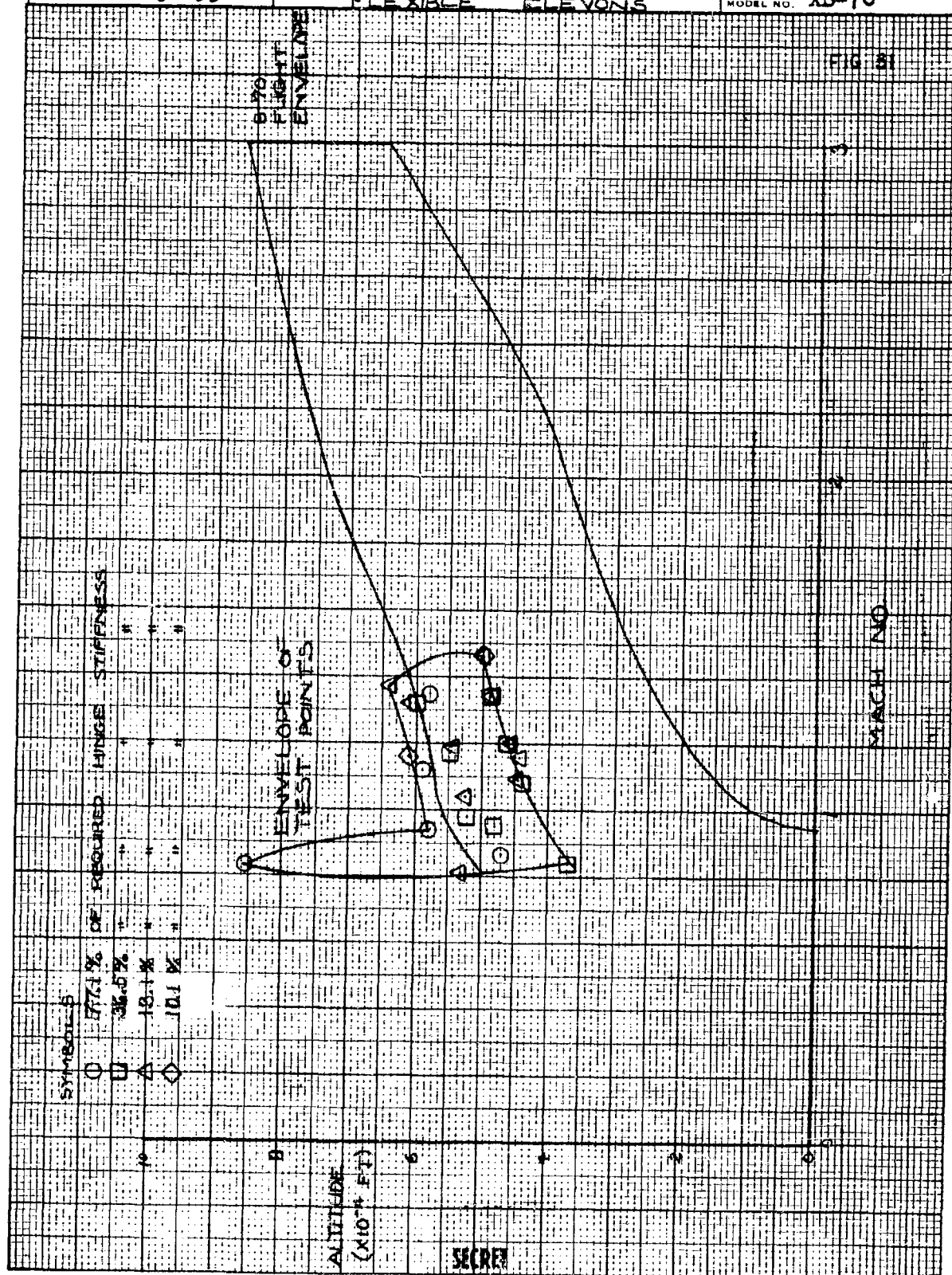
DATE

11-30-59

FLEXIBLE ELEVONS

MODEL NO. XB-70

FIG. 31



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FILE NO. HKA

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J.R.S.

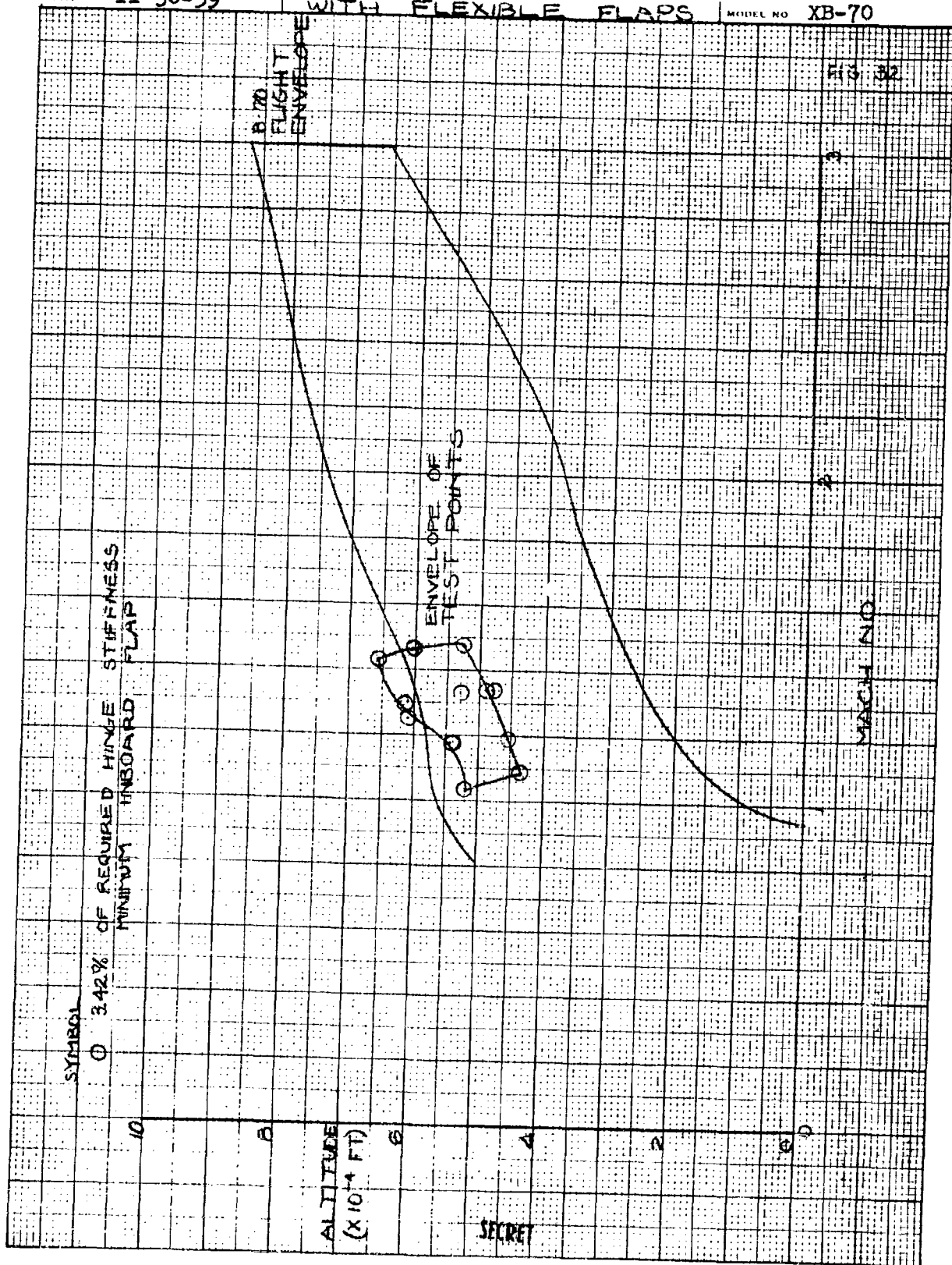
20 SCALE STIFF CANARD

NA-59-1736

DATE 11-30-59

WITH FLEXIBLE FLAPS

MODEL NO XB-70



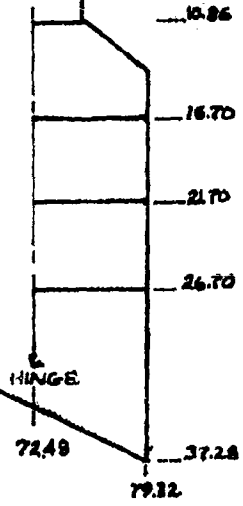
SECRET

PREPARED BY:   
CHECKED BY:   
DATE: 11/2

1

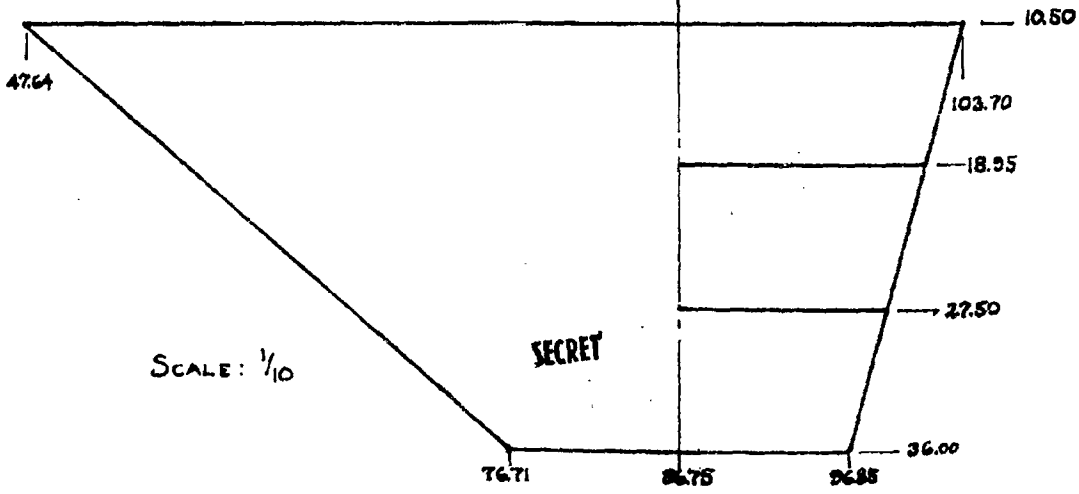
SCALE: 1/10

← AIRPLANE



← AIRPLANE

← HINGE



SCALE: 1/10

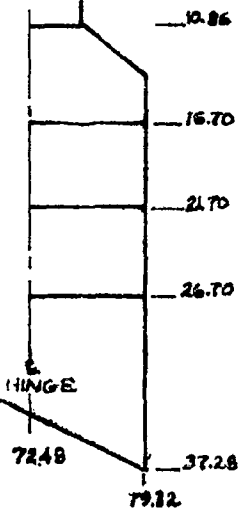
SECRET

PREPARED BY: <u>HKA</u>	NORTH AMERICAN AVIATION, INC.	PAGE NO. <u>47</u> OF <u>63</u>
CHECKED BY: <u>URS</u>		REPORT NO. <u>NA-59</u> <u>1736</u>
DATE: <u>11/30/59</u>	SECRET	MODEL NO. <u>XB-70</u>

SUMMARY OF MODEL DATA  
.06 WING WITH FLEXIBLE ELEVONS  
.20 CANARD WITH FLEXIBLE FLAPS

FIG. 33

ELEVONS



LOCATION	INERTIA ABOUT HL LB-IN-SEC <sup>2</sup>		ZERO AIRSPEED ROTATION FREQ. CPS			
	MODEL	REQ'D	STIFF	MED	FLEX	REQ'D
INBOARD	.00948	.00926	206	139	84	267
CENTER	.01236	.01245	205	145	84	267
OUTBOARD	.01202	.01245	200	136	85	267

2

FLAPS

LOCATION	INERTIA ABOUT HL LB-IN-SEC <sup>2</sup>		ZERO AIRSPEED ROTATION FREQ CPS	
	MODEL	REQ'D	FLEX	REQ'D
INBOARD	.584	.513	26	115.0
CENTER	.496	.320	30	135.4
OUTBOARD	.289	.292	37	161.2

SECRET

PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 48 OF 63
CHECKED BY: J.R.S.	.06 SCALE LOW SPEED	REPORT NO. NA-59-1736
DATE: 11-30-59	COMPLETE MODEL	MODEL NO. XB-70

SECRET

COMPLETE MODEL TEST

Flutter trends were established by means of thirteen runs of the B-70 complete airplane configuration with variations in fuel loading and tip deflection about the 79% semi-span fold line.

The model was constructed of styrofoam and isowood. The wings were made of solid styrofoam with the thickness at any point in the planform scaled to simulate full scale bending stiffness. The fuselage was constructed of styrofoam and isowood; isowood was used as a stiffener in areas where styrofoam alone would become too thick to maintain the geometric shape. The vertical tail did not simulate stiffness but was of the correct geometric shape. The complete airplane model was constructed to a .06 geometric scale and a 1/6 speed scale.

These tests were conducted in the WSC 7 3/4 x 11 foot low speed atmospheric wind tunnel at sea level density.

A shake test was conducted to determine natural frequencies and node line locations of the first four or five symmetric and anti-symmetric modes before flutter testing the configurations. Due to the static divergence tendency induced by the suspension system, the horizontal stabilizer was removed and replaced with an equivalent weight. In cases where flutter was obtained, the flutter frequency fell near the zero air speed frequencies for fuselage vertical bending or wing bending indicating the importance of these modes in determining the flutter speeds.

These tests were conducted on the -44C configuration. Subsequent to these tests the -70A configuration has evolved with a shortened and stiffer forward fuselage.

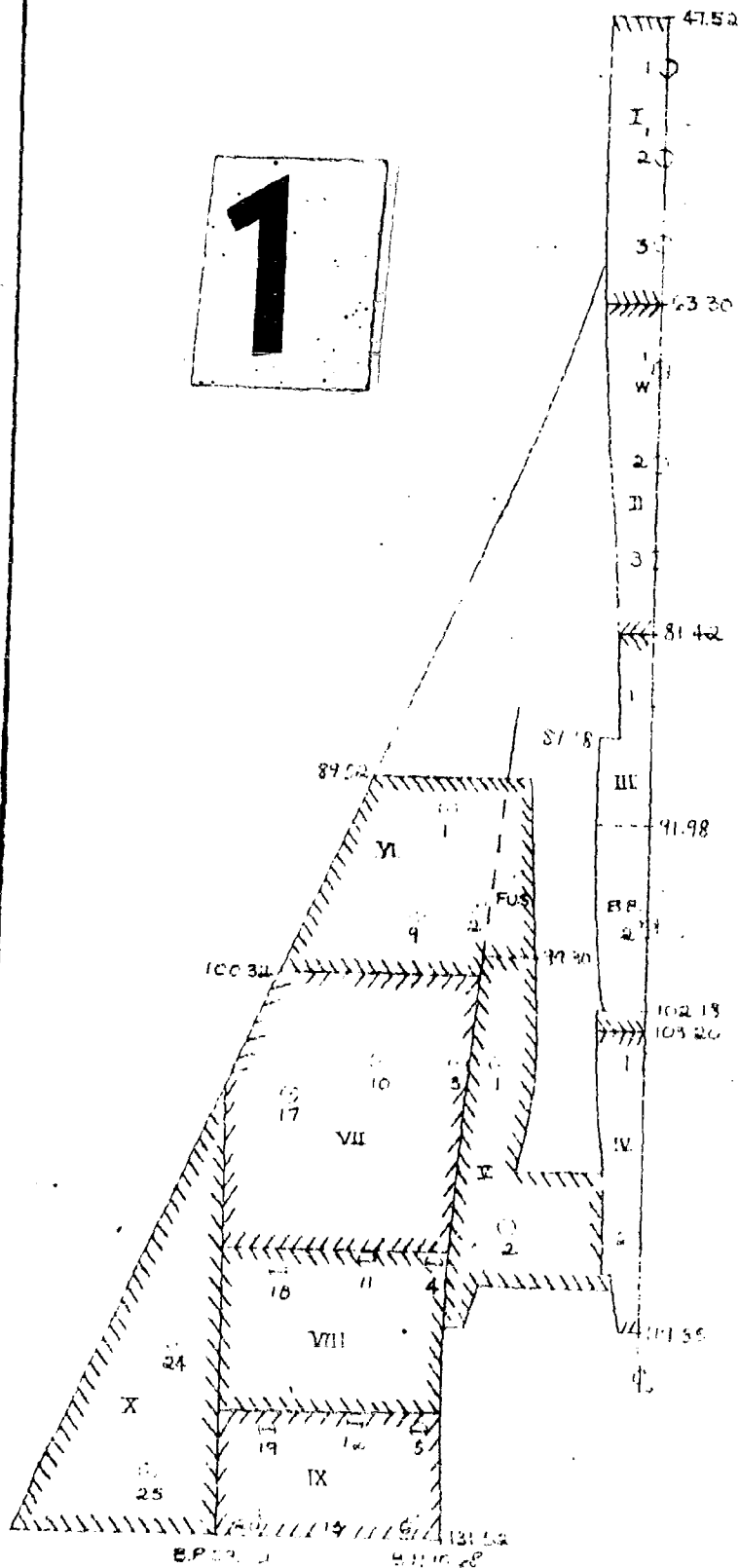
SECRET

PREPARED BY:

CHECKED BY,

DATE 5-13-61

1



FULL SCALE			MODEL SCALE					
WEIGHT LBS.	C.G. OF AIR VEHICLE INS.	ORDER OF SEQUENCE	TANK NO.	WEIGHT NO.	AMOUNT OF BALLAST REM'D.	BALLAST C.G.		WEIGHT LBS.
						F.S. INS.	B.P. INS.	
536,810.3	1602.5							
					← FULL CONDITION →			
			X	24	ALL	121.188	25.500	115.95
527,430.3	1593.9	A		25	ALL	128.142	26.754	113.92
510,431.6	1611.1	B	I	1	ALL	50.244	-	110.25
			VII	FUS.	ALL	94.866	7.380	
				1	ALL	91.152	11.058	
				2	ALL	96.510	9.366	
474,385.6	1621.7	C		9	ALL	96.888	12.648	102.47
			VII	3	ALL	105.270	10.236	
				10	ALL	105.210	14.550	
				17	ALL	107.100	19.440	
				4	$\frac{1}{2}$	116.364	11.298	
				11	$\frac{1}{2}$	116.190	15.018	
438,000.3	1604.2	D		18	$\frac{1}{2}$	116.844	19.944	94.61
421,001.6	1631.9	E	I	2	ALL	55.032	-	90.94
			VIII	4	$\frac{1}{2}$	116.364	11.298	
				11	$\frac{1}{2}$	116.190	15.018	
				18	$\frac{1}{2}$	116.844	19.444	
				5	$\frac{1}{2}$	125.556	11.974	
				12	$\frac{1}{2}$	125.100	15.360	
395,717.4	1608.3	F		19	$\frac{1}{2}$	125.670	20.130	85.48

ARMAMENT TO BE DROPPED AT PILOT'S

**SECRET**

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PREPARED BY: AJE	NORTH AMERICAN AVIATION, INC.	PAGE NO. 49 OF 63
CHECKED BY: VLR	ORDER OF FUEL SEQUENCING	NA-59-1736 -44C
DATE: 5-13-59	.06 NAAL COMPLETE MODEL (REVISION OF DATA RELEASED 2-5-59)	MODEL NO. XE-70

MODEL SCALE							FULL SCALE		MODEL SCALE							
TANK NO.	WEIGHT NO.	AMOUNT OF BALLAST REM'D.	BALLAST C.G.		WEIGHT	C.G. OF AIR VEHICLE	WEIGHT	C.G. OF AIR VEHICLE	ORDER OF SEQUENCE	TANK NO.	WEIGHT NO.	AMOUNT OF BALLAST REM'D.	BALLAST C.G.		WEIGHT	C.G. OF AIR VEHICLE
			F.S. INS.	B.P. INS.	LBS.	INS.	LBS.	INS.					F.S. INS.	B.P. INS.	LBS.	INS.
FULL CONDITION					115.95	96.15	378,718.7	1635.7	B	I	3	ALL	59.820	-	81.80	98.14
X	24	ALL	121.188	25.500						IX	5	1/2	125.556	11.874		
	25	ALL	128.142	26.754	113.92	95.64					12	1/2	125.100	15.360		
I	1	ALL	50.244	-	110.25	97.15					13	1/2	125.670	20.130		
VI	FUS.	ALL	94.866	7.380							6	ALL	130.296	11.880		
	1	ALL	91.152	11.058							13	ALL	130.296	15.414		
	2	ALL	96.510	9.366			363,426.0	1615.5			20	ALL	130.296	20.178	78.50	96.93
	9	ALL	96.888	12.648	102.47	97.30	348,506.7	1637.0	I	II	1	ALL	66.810	-	75.28	98.22
VII	3	ALL	105.270	10.236						V	1	ALL	105.300	8.040		
	10	ALL	105.210	14.550			312,701.7	1610.6	V		2	ALL	114.240	7.416	67.55	96.64
	17	ALL	107.100	19.440						II	2	ALL	72.048	-		
	4	1/2	116.364	11.298							3	ALL	77.280	-		
	11	1/2	116.190	15.018						IV	1	ALL	104.382	-		
-	18	1/2	116.844	19.944	94.61	96.25	247,347.1	1623.2	K		2	ALL	114.042	-	53.43	97.39
I	2	ALL	55.032	-	90.94	97.12	222,964.1	1623.8	L	P.B.	-	ALL	97.080	-	46.16	97.43
VIII	4	1/2	116.364	11.298						III	1	ALL	80.100	-		
	11	1/2	116.190	15.018							2	ALL	97.414	-		
	18	1/2	116.844	19.944						WATER		ALL	66.900	-		
	5	1/2	125.556	11.874			137,161.1	1638.7	EMPTY CONDITION					42.59	98.32	
	12	1/2	125.100	15.360												
	19	1/2	125.670	20.130	85.48	96.50										

ARMAMENT TO BE DROPPED AT PILOT'S DISCRETION

SECRET

2

PREPARED BY: R.W.D.

NORTH AMERICAN AVIATION, INC.

PAGE NO. 50 OF 63

CHECKED BY: J.R.S.

SECRET

NA-59-1736

DATE: 11-30-59

REPORT NO.

MODEL NO. XB-70

## COMPLETE MODEL-TEST RESULTS

FIG 35

NAAL TEST # 443

RUN NO	CONFIGURATION	TIP DEFL.		FLUTTER TEST RESULT			SHAKE TEST FREQUENCIES - cps									
		0°	50°	WING	WING	PHASE	SYMMETRIC					ANTI-SYMMETRIC				
	FUEL LOADING CONDITION			Y/N	Y/N		f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>	f <sub>5</sub>	f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>	f <sub>5</sub>
1*																
2*																
3	EMPTY	✓		✓	5.6	SYM	6.3	12.0	14.1	21.4	28.7	6.0	13.5	20.7	25.5	—
4*																
5	SEQ L-H <sub>2</sub> O	✓		✓	12.5	SYM	5.5	11.8	13.8	20.0	26.9	5.9	12.9	20.3	24.7	—
6	SEQ A (FULL)	✓		✓	8.9	SYM	4.6	8.5	11.1	14.8	20.5	4.4	8.9	17.3	18.3	—
7	SEQ B	✓		✓			4.7	8.6	11.3	15.0	21.0	4.4	9.1	18.5	19.5	21.5
8	SEQ D	✓		✓			4.9	9.2	11.3	16.0	21.8	4.4	9.7	18.7	19.6	22.3
9	SEQ E	✓		✓			4.9	9.5	11.9	17.2	22.7	4.5	11.6	18.9	20.5	23.1
10	SEQ G	✓		✓			5.0	10.0	12.4	19.2	24.9	4.7	12.1	19.5	21.8	23.5
11	SEQ K (H <sub>2</sub> O)	✓		✓			5.2	11.1	12.7	22.3	25.6	5.2	12.7	20.6	24.8	—
12	EMPTY		✓	✓	6.3	SYM	6.3	12.9	14.1	21.5	29.3	6.4	13.5	20.4	27.3	—
13	SEQ A		✓	✓			4.7	8.7	10.3	15.1	21.0	4.4	9.0	16.4	17.5	—
14*	EMPTY	✓		✓	2.5	SYM	4.7	12.2	13.6	22.3	27.8	—	—	—	—	—
15*	EMPTY	✓		✓	1.5	SYM	4.6	12.2	15.2	22.9	27.4	—	—	—	—	—
16	SEQ A	✓		✓	9.4	SYM	4.8	8.9	10.4	15.4	—	—	—	—	—	—

## MODEL CHARACTERISTICS

GEOMETRIC SCALE.....06

CONTROL SURF.....STIFF

SPEED SCALE.....1/6

SUPPORT.....SUSPENSION SYST

MATERIAL.....STYROFOAM

HINGE FOLD STIFF.....10% ~

ALTITUDE.....SEA LEVEL

HORIZ STAB INCIDENCE...NONE

TIP DEFLECTION.....VARIABLE

FUEL LOADING.....VARIABLE

\* THESE RUNS WERE MADE TO ORIENT THE MODEL. NO TEST DATA OBTAINED. SUBSEQUENT RUNS WERE MADE WITH NO HORIZONTAL STABILIZER.

\*\* STIFFNESS INCREASED 100%-150% FROM ANTENNA TO REAR.

\*\*\* STIFFNESS 1/2 OF RUN #14 FROM ANTENNA TO REAR.

\*\*\*\* STIFFNESS SAME AS RUN #15

SECRET

PREPARED BY: H.K.A.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 51 of 63
CHECKED BY: J.R.S.	SECRET	REPORT NO. NA-59-1736
DATE: 11-30-59		MODEL NO. XB-70

### .10 SCALE TRANSONIC WING

This model simulated the -44 C configuration. Three identical cantilever models were constructed with 0° tip deflection.

The stiffness of the wings was scaled to simulate a Mach number of 1.05 at sea level, with the stiffness reduced by a factor  $1/1.32$ , so that in the event flutter occurred at conditions corresponding to the flight boundary, the required margin would be demonstrated at the correct mass ratio.

The models were constructed of a styrofoam core covered with aluminum skins of various thicknesses, consistent with full scale construction. The joints of the skins were overlapped and secured with glue. Subsequent tests of this glue showed it to be flexible which was indicated by the shake test frequencies being too low by 23%.

This test was conducted at TWT on 3/2/59 through 3/3/59 for seven test hours.

The purpose of the test was to determine the variation of flutter characteristics with Mach number in the transonic region. Flutter was not obtained and large margins were demonstrated.

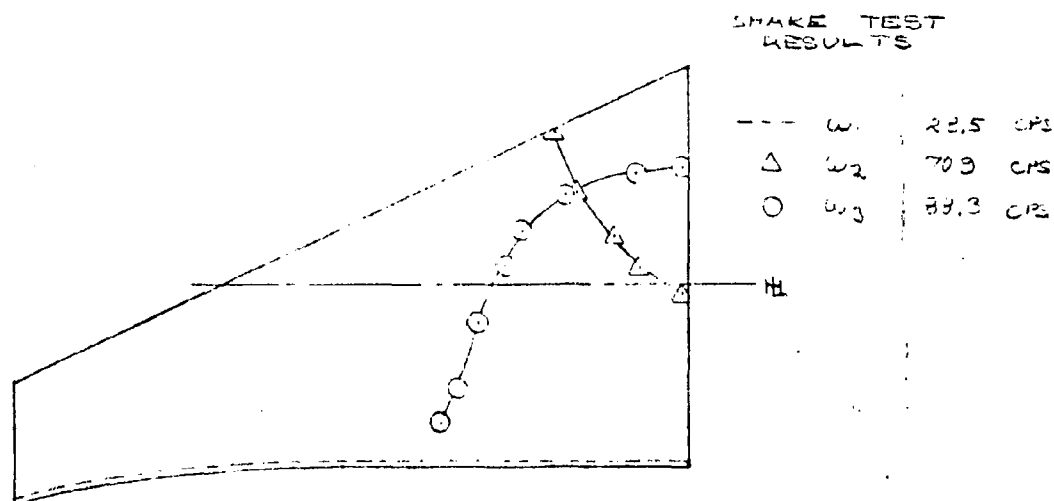
SECRET

PREPARED BY: HKA	NORTH AMERICAN AVIATION, INC.	PAGE NO. 52 OF 63
CHECKED BY: J.R.S.	.10 SCALE TRANSONIC	NA-59-1736 REPORT NO.
DATE: 11/11/59	WING SECRET	MODEL NO. XB-70

FIG. 36

# 44C CONFIGURATION

MODEL SCALE	.10
MATERIAL	STYROFOAM CORE ALUMINUM SKIN
SUPPORT	CANTILEVER FLOOR MOUNT
HINGE STIFFNESS	67544 IN-LB/RAD
FUEL LOADING	EMPTY
TIP DEFLECTION	0°



NOMINAL MACH NUMBERS TESTED :

1.95

1.05

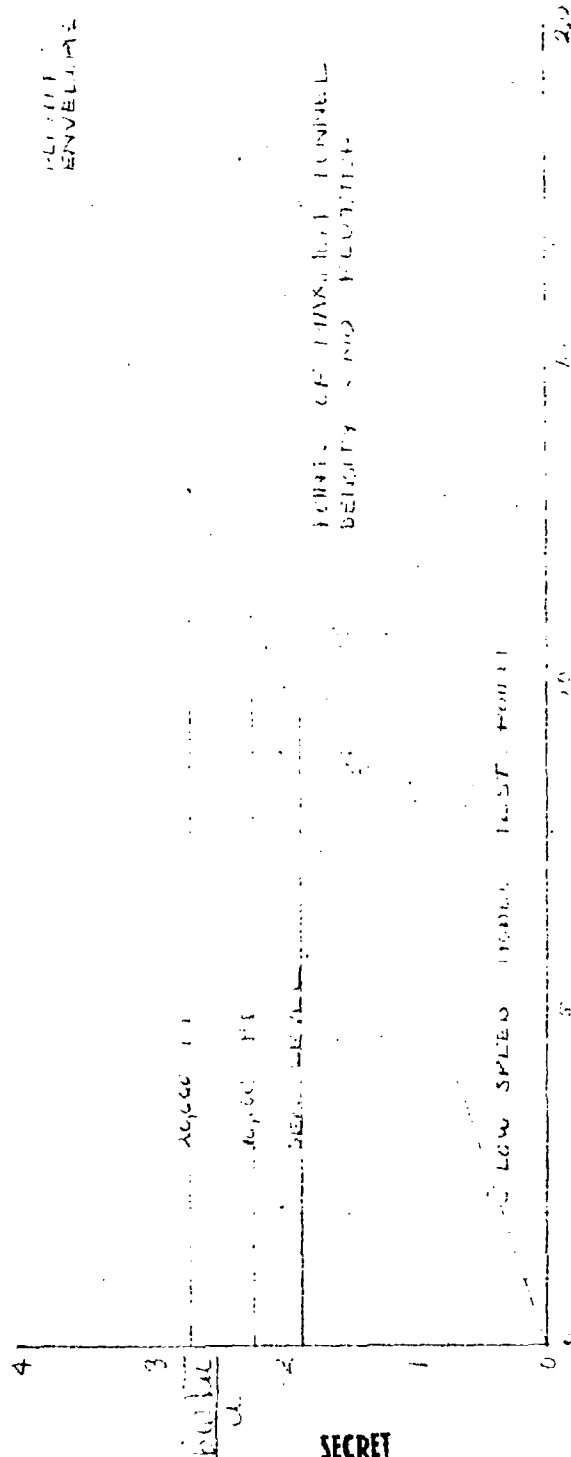
1.10

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PREPARED BY: <b>TKD</b>	NORTH AMERICAN AVIATION, INC. <b>SECRET</b>	PAGE NO. <b>53</b> OF <b>63</b>
CHECKED BY: <b>J.R.S.</b>		REPORT NO. <b>NA-59-1736</b>
DATE: <b>11/13/59</b>	<b>WING</b>	MODEL NO. <b>XR-72</b>

FIG 37

**b -** 1/2 CHORD AT 3/4 SPAN  
**a -** FIRST TANGENTIAL FREQUENCY  
**u -** RATIO OF MASS OF WING  
 OUTBOARD OF FWD LINE TO  
 MASS OF ONE LEAF OF  
 DIAPHRAGM AT GAGE = 20  
 AND FIELD OF VISION  
 FROM FWD LINE TO WING TIP  
**a -** SPEED OF SOUND AT ANY  
 ALTITUDE



**SECRET**

PLATE  
ENVELOPE

POINT OF MAXIMUM TANGENTIAL  
VELOCITY AND FLUTTER

PLATE NO.

PREPARED BY: H.K.A.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 54 OF 63
CHECKED BY: H.R.S.	SECRET	REPORT NO. NA-59-1736
DATE: 11-30-59		MODEL NO. XB-70

### .10 SCALE TRANSONIC WING

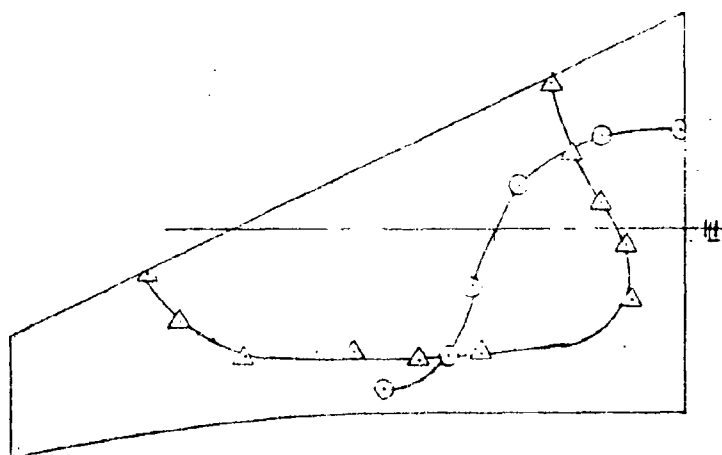
These models are the same as the previous .10 scale transonic wings except as modified to incorporate 25° and 50° wing tip deflection. The purpose of the tests was to investigate the effect of wing tip deflection on flutter speeds at a low supersonic Mach number. Tests were conducted at  $M = 1.10$  with variable tunnel density in TWT on 4/21/59 through 4/23/59 for 33 test hours. Static air loads destroyed the model with 50° tip deflection and flutter was not encountered for either the 0° or 25° tip deflection models. From indications of the approach to flutter for 0° deflection it may be concluded that 25° deflection causes no appreciable reduction in flutter speed. Very large margins were demonstrated.

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PREPARED BY: HKA	NORTH AMERICAN AVIATION, INC.	PAGE NO. 55 OF 63
CHECKED BY: J.R.S.		NA-59-1736 REPORT NO.
DATE: 11/12/59	WING SECRET	MODEL NO. XB-70

# SHAKE TEST RESULTS

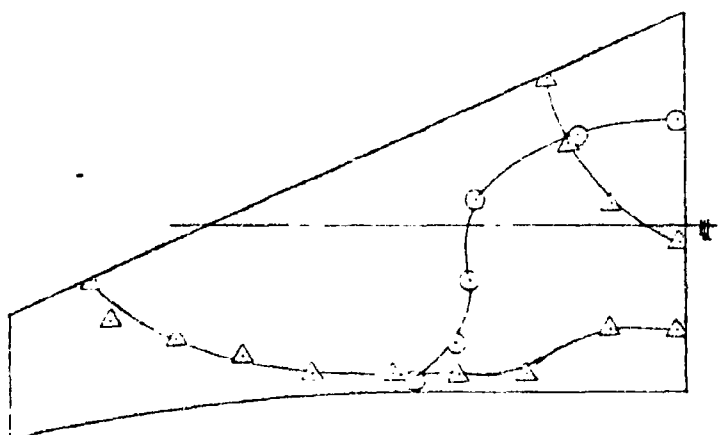
FIG. 38



0° TIP DEFLECTION

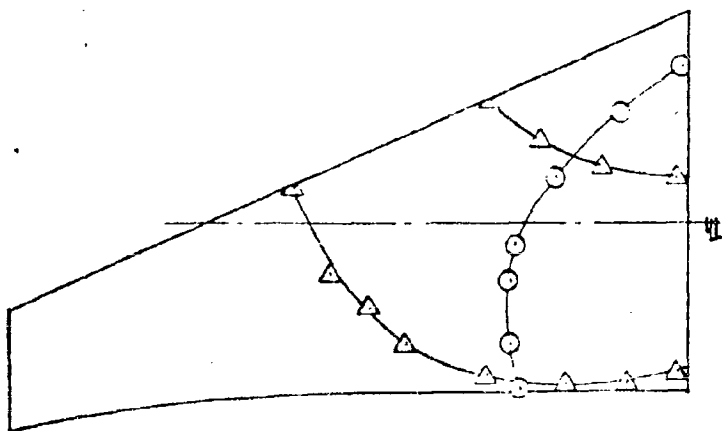
CPS

$\omega_1$	31.1	
$\omega_2$	70.7	$\Delta$
$\omega_3$	90.2	$\circ$



25° TIP DEFLECTION

$\omega_1$	31.9	
$\omega_2$	72.2	$\Delta$
$\omega_3$	85.4	$\circ$



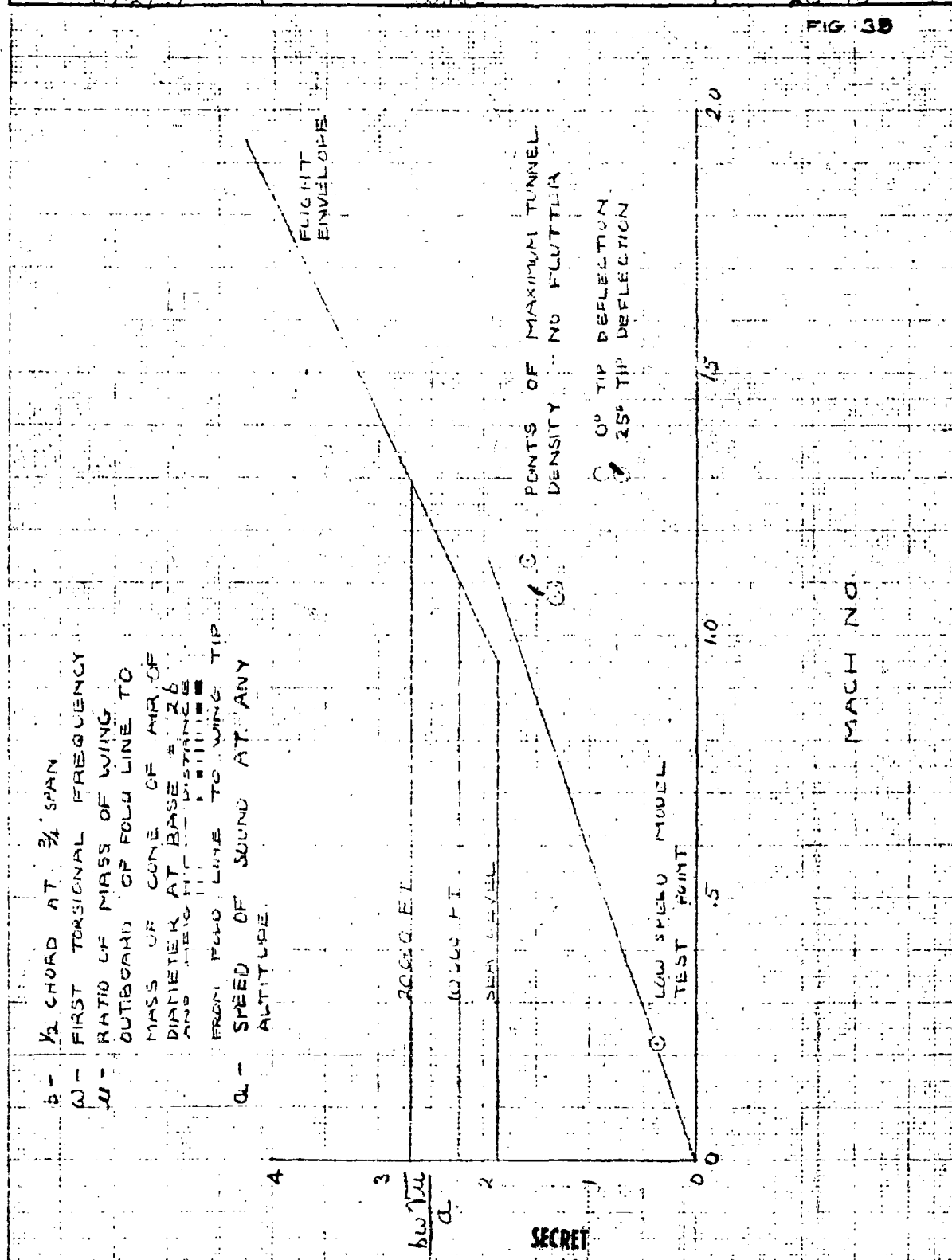
50° TIP DEFLECTION

$\omega_1$	31.2	
$\omega_2$	69.8	$\Delta$
$\omega_3$	80.9	$\circ$

SECRET

PREPARED BY: HKA	NORTH AMERICAN AVIATION, INC.	PAGE NO. 56 63
CHECKED BY: J.R.S.		REPORT NO. NA-59-1736
DATE: 11/12/59	10 SCALE TRANSONIC	MODEL NO. XB-72

FIG 38



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PREPARED BY: H.K.A.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 57 OF 63
CHECKED BY: J.R.S.	SECRET	REPORT NO. NA-59-1736
DATE: 11-30-59		MODEL NO. XB-70

### .20 SCALE TRANSONIC VERTICAL TAIL

Three identical models of the vertical tail were constructed simulating the -44C configuration including root flexibility.

The model was constructed of a styrofoam core with aluminum skins, the same type of construction as was used for the .10 scale transonic wings. Comparison of shake test results and other vertical stabilizer models has indicated that these models were too flexible, i.e., the frequencies were lower than required by design model factors by approximately 14-1/2 per cent as a result of excessive glue joint flexibility. Since mass parameters were correct, this lower stiffness level still provides full usable data.

Six flutter points were obtained during the test. As observed with high speed motion picture photography, the flutter mode was first bending-first torsion with a large torsion component.

The shapes of the flutter boundary curve and the T.W.T. operation characteristic curve led to flutter at several points during a blow. The changing tunnel conditions removed the model from a flutter range before model damage occurred. The maximum density flutter point obtained in each case then caused model damage.

The test was conducted in TWT from 3/4/59 through 3/3/59 for 30 test hours.

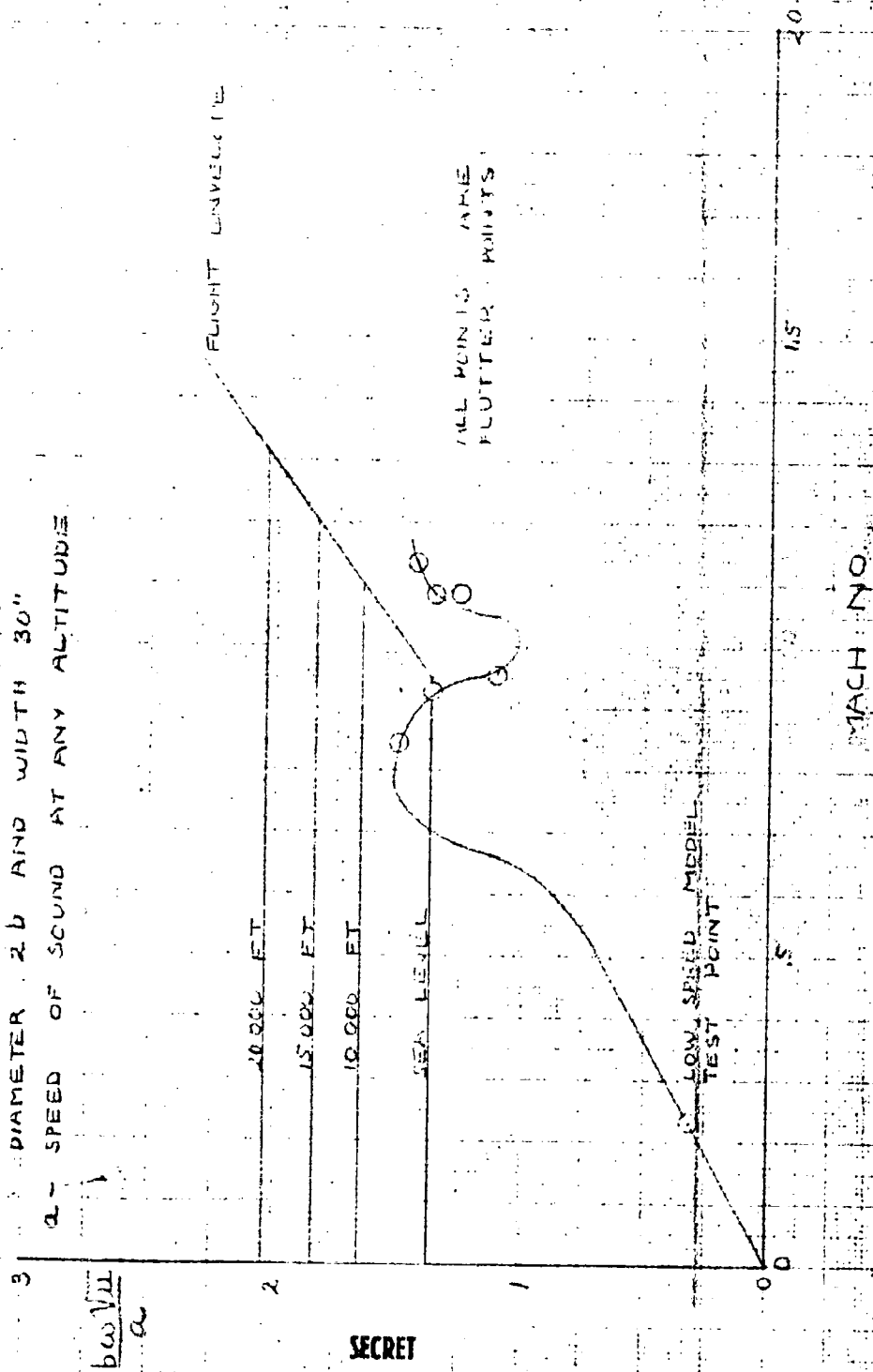
From this test it was concluded that, for the configuration tested, an increase of 10% in torsion stiffness would be required in the midspan region in order to provide the required margin of safety.

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PREPARED BY: HKA	NORTH AMERICAN AVIATION, INC.	PAGE NO. 59 OF 69
CHECKED BY: J.R.S.		NA-59-1736
DATE: 11/12/59	20 SCALE TRANSFORMING VERTICAL	MODEL NO. XB-70

FIG 40

- b - 1/2 CHORD AT 1/4 SPAN
- w - FIRST TORSIONAL FREQUENCY
- u - RATIO OF MASS OF STRIP 30" WIDE (FULL SCALE STREAMWISE) AT 3/4 b, TO MASS OF CYLINDER OF AIR OF DIAMETER 2b AND WIDTH 30"
- a - SPEED OF SOUND AT ANY ALTITUDE



PREPARED BY: R.W.D.	NORTH AMERICAN AVIATION, INC.	PAGE NO. 60 OF 63
CHECKED BY: H.R.S.	SECRET .20 SCALE LOW SPEED	REPORT NO. NA-59-1736
DATE: 11-30-59	HORIZONTAL STABILIZER	MODEL NO. XB-70

### HORIZONTAL STABILIZER

Flutter trends were established by means of a total of twenty-four runs of the B-70 horizontal stabilizer with variation in pitch and yaw stiffness, flap locked and unlocked, and angle of incidence.

The  $1/5$  geometric scale model with a  $1/6$  velocity scale, was constructed of solid styrofoam with the thickness at any point in the planform scaled to simulate full scale bending stiffness. The flap was free to rotate about its hinge line hinges which were constructed so that the flap could be locked in position also. Flap actuator stiffness was simulated by a pair of springs attached to a wheel-type ring at the end of a cylindrical tube. The model mass simulated full scale mass data.

Pitch stiffness and yaw stiffness was simulated by small cantilevered beam springs. The springs were calibrated dynamically by attaching a known mass on the spring and recording the free vibration on an oscillograph record for each length of spring.

A shake test was conducted to determine natural frequencies and node lines of the first four symmetric and anti-symmetric modes prior to the actual flutter test of each configuration. These tests were conducted in the WSC  $7 \frac{3}{4}$  x 11 foot low speed atmospheric wind tunnel at sea level density.

These tests demonstrated adequate margin for all configurations except those including unlocked flaps and indicated that further study was required to optimize the design for adequate margin with respect to the 300 KIAS limit speed for the flaps unlocked case.

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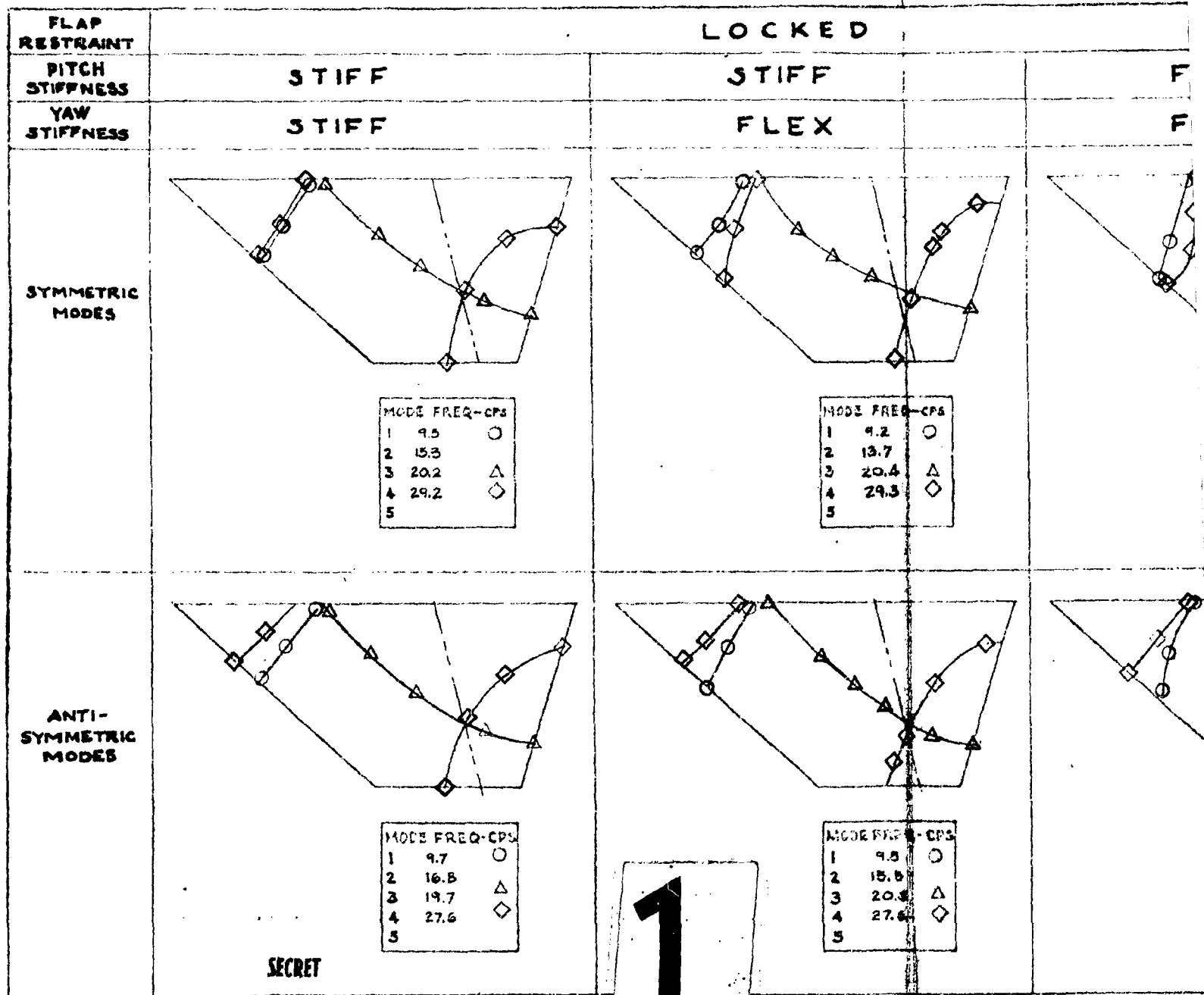
# B-70 HORIZONTAL STABILIZER NAAL TEST 445 MODEL CHARACTERISTICS

GEOMETRIC SCALE  
SPEED SCALE  
MATERIAL SOLID STYROFOAM  
SPRING CONSTANTS

$\frac{1}{5}$   
 $\frac{1}{6}$   
PITCH  
YAW

ALTITUDE  
CONTROL SURFACE  
SUPPORT  
STIFF  
FLEXIBLE  
STIFF  
FLEXIBLE

FLAP INERTIA ABOUT  $H_L$



SECRET

1

# 

NAAL TEST 445

## 

1/5	ALTITUDE	SEA LEVEL
1/6	CONTROL SURFACE	VARIABLE
ROFOAM	SUPPORT	SPECIAL MOUNT
PITCH	STIFF	42,850 IN.LBS/RAD
	FLEXIBLE	18,385 IN.LBS/RAD
YAW	STIFF	32,150 IN.LBS/RAD
	FLEXIBLE	22,950 IN.LBS/RAD
		.04455 IN-LBS-SEC <sup>2</sup>

PREPARED BY:	
CHECKED BY:	J.R.
DATE:	

LO

STI

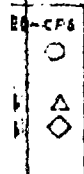
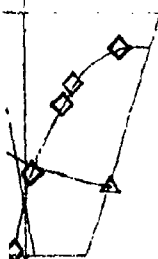
FL

FLEX

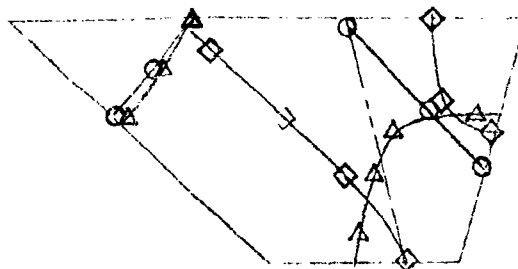
FLEX

STIFF

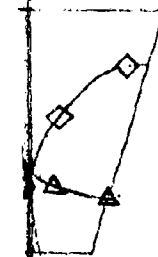
STIFF



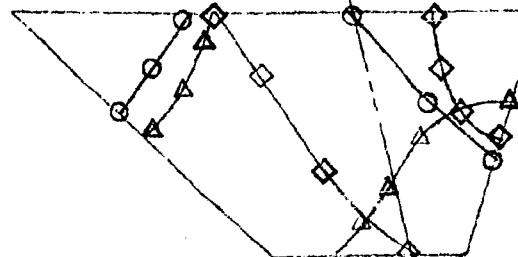
MODE FREQ-CPS	
1	8.4
2	13.7
3	19.5
4	25.0



MODE FREQ-CPS	
1	11.3
2	16.9
3	25.9
4	33.7
FLAP	4.8



MODE FREQ-CPS	
1	8.6
2	13.8
3	19.6
4	26.8



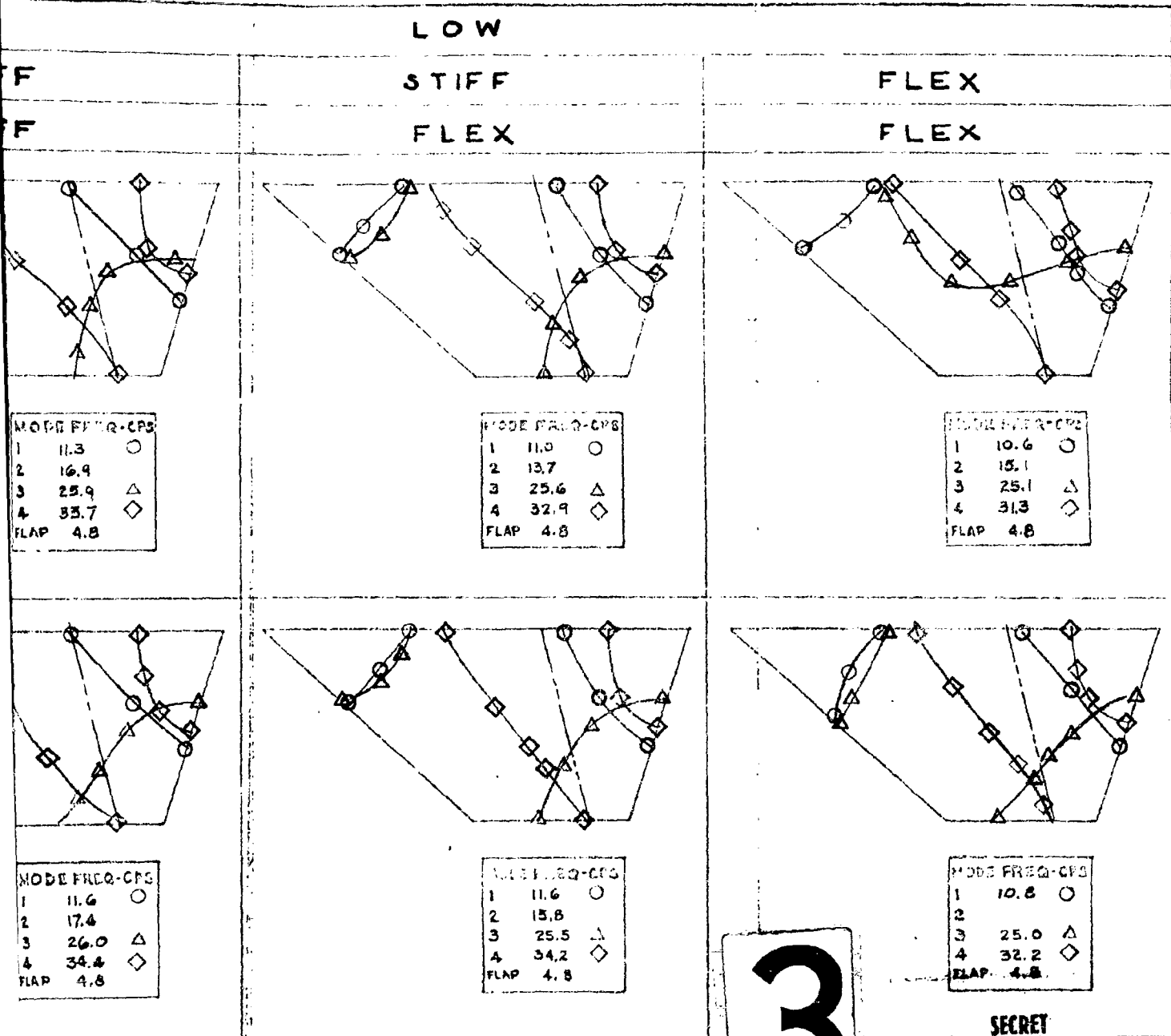
MODE FREQ-CPS	
1	11.6
2	17.4
3	26.0
4	34.4
FLAP	4.8

2

DESIGNED BY	NORTH AMERICAN AVIATION, INC.	FIG. NO. 62
CHECKED BY JRS	INTERNATIONAL AIRPORT LOS ANGELES 45, CALIFORNIA	NA-59-1736
DATE	SHAKE TEST RESULTS - HORIZ STAB	REPORT NO.
		XB-70

SECRET

FIG 42



3

SECRET

R.W.D.

H.R.S.

11-30-59

SECRET

FULL SCALE MODEL OF CANARD  
LOW SPEED 1/15 SCALE

62 63

NA-59-1736

XB-70

FIG 43

TEST CONFIGURATIONSMAXIMUM SPEED AND FLUTER FREQ.

FLAP		LOCKED			LOW			FREE		
ANGLE		0°	3°	6°	0°	3°	6°	0°	3°	6°
YAW	STIFF	172			67	68.5	73	67	71	73.5
		—			10.1	10.2	10.4	10.4	10.7	10.8
	MED									
STIFF	FLEX									
MEDIUM	STIFF									
	MED									
	FLEX									
FLEXIBLE	STIFF	175			65.5	66	73	65.5	68.5	74
		—			10.71	10.69	10.89	10.4	10.5	10.5
	MED									
	FLEX	160	145		60	60	61.5	57	59	62
		—	—		10.00	10.08	10.19	9.48	9.47	9.64

SECRET



SECRET

IZER

DESIGNED BY: J.E.	NORTH AMERICAN AVIATION, INC.	DATE: 10-1-50
TESTED BY: JRS		REMARKS: 10-1-50
DATE: 10-1-50		TESTED BY: JRS

FIG 44

SEA LEVEL  
 VARIABLE  
 SPECIAL MOUNT

OSCIL. REC. NO.	MAX SPEED MPH	FLUTTER		FLUTTER MOTION PHASE	SHARE TEST RESULTS										FLUTTER FREQ Hz	FLUTTER RPM
					SYMMETRIC					ANTI-SYMMETRIC						
		YES	NO		f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>	f <sub>5</sub>	f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>	f <sub>5</sub>		
					10.6	15.1	25.1	29.2		10.6	15.1	25.1	29.2			
2607	60	✓		SYM	10.6	15.1	25.1	29.2		10.6	15.1	25.1	29.2		10.00	
2608	60	✓													10.00	
2609	61.5	✓													10.19	
2610	62	✓													9.64	
2611	59	✓													9.47	
2612	57	✓													9.48	
2614	60		MADE		8.4	13.7	14.5	29.0		8.4	13.7	14.5	29.0		13.10	
2621	124		✓													
2622	65.5	✓			11.0	13.7	25.6	29.1		11.0	13.7	25.6	29.1		10.71	
2623	66		MADE												10.69	
2624	73	✓													10.89	
2628	74	✓													10.5	
2629	63.5	✓													10.5	
2630	65.5	✓													10.4	
2635	75		✓		9.2	13.7	25.6	29.3		9.2	13.7	25.6	29.3			
2637	67	✓			11.3	16.9	25.9	29.7		11.3	16.9	25.9	29.7		11.1	
2638	68.5	✓													11.1	
2639	73	✓													11.1	
2641	73.5	✓													10.97	
2642	71	✓		↓											10.71	
2643	67	✓		ANTI-SYM											10.47	
2645	172		✓	SYM	9.5	15.3	25.2	29.2		9.5	15.3	25.2	29.2			
2653	145		✓	↓	8.4	13.7	19.3	29.0		8.4	13.7	19.3	29.0			

SECRET

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